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THE PERFORMANCE OF WOOD FRAME WALLS WITH RESPECT TO RESISTANCE AGAINST DOOR JAMB SPREADING

Forintek Canada Corp.

A REPORT

For

Mr. R.D. Stapleton

Project Implementation Division

CMHC National Office

THE PERFORMANCE OF WOOD FRAME WALLS WITH RESPECT TO RESISTANCE AGAINST DOOR JAMB SPREADING

By

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SUMMARY

The Task Group on Physical Security in Residential Buildings of the Associate Committee on Part 9 of the National Building Code of Canada, herein called the Task Group, requires test data in order to judge the appropriateness of a proposed requirement for solid blocking at lock height in two stud spaces on each side of an exterior door.

The objective for this work is to evaluate the effectiveness of various strategies of increasing the resistance of residential door frame and wall assemblies against forced entry by jamb spreading.

Nine wall designs were selected for test and these included the use of blocking at lock height constructed both wet and dry. Measurements were made of the shrinkage of the studs during drying. Three replications were made of each type. The test method was based on ASTM F476 on the security of swinging door assemblies but was modified to study the effect of the wall construction rather than the door assembly.

The results showed that the use of waferboard as exterior sheathing was more effective than blocking, extra studs, reduced nail spacing or gypsum board sheathing in providing resistance against jamb spreading.

TABLE OF CONTENTS

1.0 INTRODUCTION 1

2.0 BACKGROUND 1
- 2.1 ASTM Standard F476 Method of Testing Wall/Jamb Stiffness 1
- 2.2 Previous Work 2
- 2.3 Shrinkage 4

3.0 OBJECTIVE 5

4.0 EXPERIMENTAL PLAN 5
- 4.1 The Standard Test Method 5
- 4.2 The Proposed Test Method 6
- 4.3 Wall Specimens 7

5.0 RESULTS AND DISCUSSION 10

6.0 CONCLUSIONS 16

7.0 RECOMMENDATIONS 18

8.0 REFERENCES 18

LIST OF TABLES

Table 1. NILECJ/CTRF Criteria for jamb/wall stiffness. 2

Table 2. The construction of wall specimens 9

Table 3. Resistance against jamb spreading at two gaps with security class and failure description in descending order of resistance. 11

Table 4. The effect of various construction details on resistance to jamb spreading. 16

LIST OF FIGURES

Figure 1. Apparatus for testing wall specimens for resistance to door jamb spreading. 7

Figure 2. Cross-section through test wall showing extra stud. . . . 10

Figure 3. An example of bottom plate shear failure. 12

Figure 4. An example of a panel shear failure. 12

Figure 5. An example of local lock height failure in gypsum board. 13

1.0 INTRODUCTION

The Task Group on Physical Security in Residential Buildings of the Associate Committee on Part 9 of the National Building Code of Canada, herein called the Task Group, requires test data in order to judge the appropriateness of a proposed requirement for solid blocking at lock height in two stud spaces on each side of an exterior door. This proposal has received approval in a set of proposed changes to the 1985 British Columbia Building Code. The intent of the proposal is to increase the resistance against the spreading of the door jamb by burglars.

Concerns raised by the Task Group against this provision included the effect of shrinkage on the effectiveness of the blocking to perform the intended function, the effect of exterior and interior sheathing in stiffening the rough frame and that a one inch deadbolt by itself provides enough protection against frame spread.

2.0 BACKGROUND

2.1 ASTM Standard F476 Method of Testing Wall/Jamb Stiffness

Being one of 21 possible tests described in ASTM F476, the test of jamb/wall stiffness is conducted on a door with a jamb installed in a 'representative' wall. The test consists of applying a horizontal force at lock height which will force the door frame to spread to a point where the deadbolt is rendered ineffective. The force required and the separation of the lock-front relative to the strike are measured.

The ASTM test method was based on the work of two California laboratories who specialize in law enforcement and crime prevention methods. An appendix of ASTM F476 provides their criteria for acceptable performance in the jamb/wall tests. Their criteria, shown in Table 1,

are given as combined strength and stiffness criteria in four security classifications.

Table 1. NILECJ/CTRF Criteria for jamb/wall stiffness.

CLASS	SECURITY APPLICATION	MAXIMUM GAP		MINIMUM FORCE	
		[in.]	[mm]	[lbf]	[kN]
grade 10	residential low-crime	3/8	9.5	1350	6
grade 20	residential average-crime	3/8	9.5	1800	8
grade 30	residential high-crime	1/2	12.7	3600	16
grade 40	residential exceptionally high semi-skilled burglary	1/2	12.7	4950	22

2.2 Previous Work

Chauret (1983) reported on a series of tests based on the ASTM F 476-76 test method for jamb/wall stiffness. The purposes of these tests were to determine the stiffness of the door frame and to investigate the influence of the position of shims, the addition of a drop deadbolt lock and horizontal blocking in the adjacent stud cavities on the performance of the door frame.

A lever and dynamometer apparatus was used to apply and measure the force necessary to enable the door to be opened. Chauret (1983) does not

report the separation between the door and jamb nor the length of the lock that was used. His tests on a drop type deadbolt lock showed that the separation was negligible in this case and that the lock-block and face of the door failed first.

From photographs in his report, it appears that the minimum nail spacing that is specified in NBCC Part 9 for attachment of the gypsum board sheathing was followed. A strip of the gypsum wall sheathing which appears to be about 4 inches in width was removed at lock height in order to allow the insertion of blocking after some of the initial tests were completed. Two door frames were tested - one 3 times and the second 5 times -using the same wall specimen. Blocking was installed only for the fourth and fifth test on the second frame.

His results showed that the addition of blocking did not affect the load at which the lock was disengaged, in fact, it was slightly lower with blocking than without blocking. Shrinkage would not explain this result since there would not have been a large change in moisture during the test. The blocks were snug when placed in the wall. However, this result is common in load cycling nailed joints where joint stiffness in the region of cycling is lower than that above this region. Thus, in this single test, blocking is ineffective in increasing wall stiffness.

The photographs in his report suggest other possible factors. The shims for the door frame extended beyond the surface of the sheathing on each side. Thus, the force would be shared between the resistance provided by the sheathing connection, in this case minimum nailing, and the bearing of the shims on the edge of the sheathing. However the load was shared between the two, it was sufficient to enable the wall, which was 37.5 inches wide on each side of the door, to act as a short deep beam to resist the force. Additional blocking would add little to the overall stiffness of the assembly. If the sheathing was nailed to the blocking it might assist in providing support against local buckling of the sheathing, but local buckling was not reported in these tests so this might not be needed.

It appears from these results that the wall test support assembly is being tested in the ASTM F 476 wall/jamb test procedure rather than the door jamb in the case where the door frame is tightly shimmed in the opening. The factors that influence the stiffness of the wall are many and include the following :

1. the properties of the sheathing membrane on each side of the wall,
2. the properties of the framing members,
3. the properties of the connection between the two,
4. the ability for spreading forces to be transferred directly into the sheathing through bearing of the shims on the edge of the sheathing,
5. the relative stiffness of the shim bearing to that of the sheathing attachment,
6. the effects of moisture and load cycling on the above, and
7. the boundary conditions of the wall panel, particularly with respect to size and gravity loading.

2.3 Shrinkage

The Wood Handbook (1987) gives average shrinkage values for numerous species from a green condition to oven dried condition. These range from 5% to 7% in the tangential direction, 3% to 5% in the radial direction and 0.1% to 0.2% in the longitudinal direction. In lumber, width and thickness directions can be some combination of radial and tangential wood depending on how it was cut from the log. Rotary peeled veneer which is used in plywood can be considered primarily tangential in direction.

The variability in the actual shrinkage value may be considerable. The Wood Handbook (1987) gives a coefficient of variation of about 15% but this is based, it is suspected, on data that is at least 30 years old and probably did not include juvenile or reaction wood. In the

longitudinal direction when drying from green to oven-dry condition, reaction wood may shrink by about 1% or 10 times that of normal wood. Juvenile wood may shrink up to 5% in the longitudinal direction, which is 25 to 50 times that of normal wood; but, the shrinkage in the radial and tangential directions are reduced proportionately.

Thus, tight blocking, 14.5 inches in length, and half of two studs at either end may shrink from 0.06 to 0.25 inches depending on assumed values for shrinkage. The above shrinkage values are to a final moisture content of about 0%, whereas framing will rarely achieve a moisture content below 6%. No matter which values are assumed, shrinkage of the blocking and framing can be significant in reducing or eliminating the effectiveness of blocking even if installed tightly.

3.0 OBJECTIVE

The objective for this work is to evaluate the effectiveness of various strategies of increasing the resistance of residential door frame and wall assemblies against forced entry by jamb spreading.

4.0 EXPERIMENTAL PLAN

4.1 The Standard Test Method

The effectiveness of blocking cannot be tested using the method prescribed in ASTM F476. Primarily, this is because ASTM F476 uses a 'standard' wall in which various doors and door frames can be tested for wall/jamb spreading. In this case, the objective is to study the effect of blocking on the stiffness of the wall. In addition, the effect of other wall designs on the stiffness of the wall is also to be studied. The placement, thickness and quality of shims between the door jamb and the wall affects the stiffness of the jamb/molding assembly.

Moreover, the specifications for the 'standard' wall in ASTM F476 leaves much to be desired. The moisture content, wood species and specific gravity range are known to affect the performance of wood nailed joints and therefore the performance of the wall. None of these are specified in ASTM F476.

4.2 The Proposed Test Method

Except for the following, the wall framing for each specimen followed that specified in ASTM F476. The bottom plate was removed under the door. This allowed some movement between the bottom plate and subfloor, as would occur in practice. In addition, a 5/8-in strip of waferboard was placed underneath the wall and nailed to a 2X4 on its flat face. Resistance to slip was provided by the nails and friction which was a function of the gravity loads transmitted by the wall. To simulate these loads and to hold the wall in a vertical position, 2x4 levers on edge and spaced 16 inches apart, applied a 133-lbf vertical load to the top of the test specimen. This load level was calculated to simulate the dead load from a roof structure.

An insulated steel door and wood jamb were installed in each test wall. Shims were placed between the door jamb and cripple stud at lock height and at the top and bottom of the door. A view of one face of the test apparatus is shown in Figure 1.

Each specimen was tested by deflecting the wall to 25 mm or failure by means of a hand-operated hydraulic jack. The operator attempted to create a 25-mm gap on the exterior, lock side of the door within 2 minutes but less than 3 minutes. A deflection transducer was mounted on each side of the interior side of the door at lock height to measure the gap or separation between the door and the jamb. A data acquisition recorder was used to plot load against gap on each side and to plot gap on each side against time.

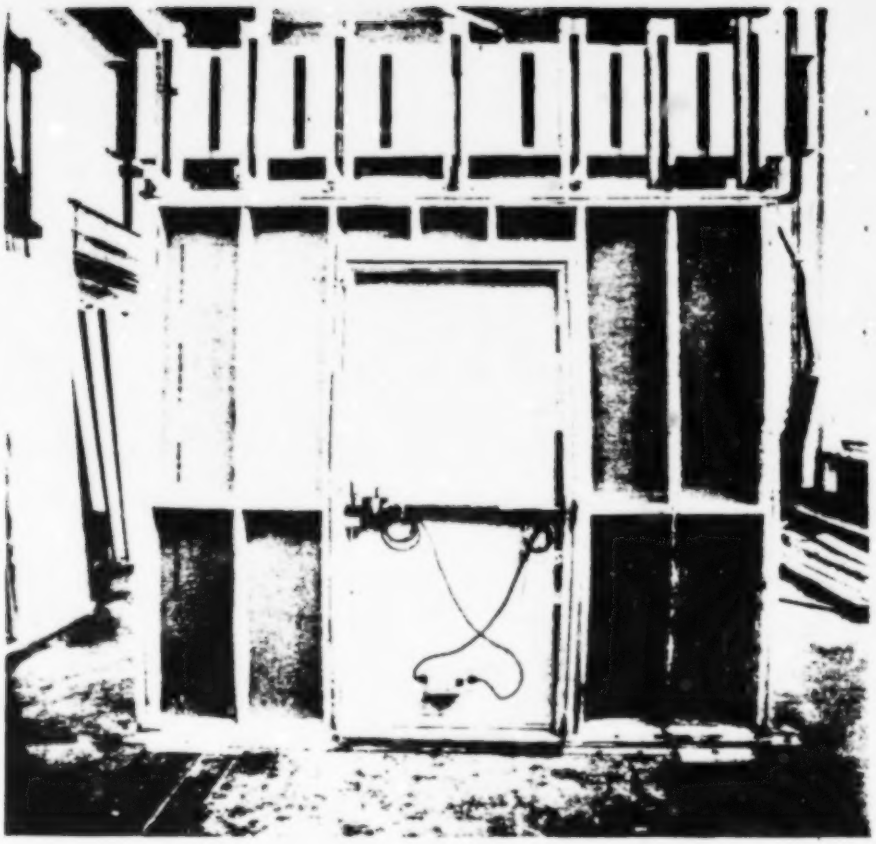

Figure 1. Apparatus for testing wall specimens for resistance to door jamb spreading.

4.3 Wall Specimens

The wall specimens were constructed in accordance with Table 1 and with stud-grade SPF lumber with an average moisture content between 15 and 20%, except for type #4 which had a moisture content at time of construction that was well above fiber saturation. The lumber was selected on the basis of matching species and quality between wall specimens. Since there were three specimens of each type, the lumber was divided into three groups. There was a high proportion of Balsam fir in the lumber that was received, so they were graded by appearance and species into the following groups:

A low grade Balsam fir

B high grade Balsam fir

C spruce

All specimens used 1/2 inch gypsum wallboard as interior finish with 1-1/4 inch drywall nails spaced 8 inches apart. Two strips of polyethylene film were used between panels and framing to reduce friction between them and to simulate conditions after years of service where a gap would create a similar effect. None of the specimens were insulated. All walls, except one group, were tested after the moisture content had dried down to below 12%.

The use of two shim materials, cedar wedges and foam insulation, were to be compared in order to assess the contribution of the compressive deformation of the shim material to the gap created when the door jambs are spread. These two materials were to be used in the wall assemblies by placing 3-in wide cedar wedges at lock height or foam insulation the full height of the door.

Table 2. The construction of wall specimens

WALL NUMBER	BLOCKING	SHEATHING	
		TYPE	NAILING
1	no	7/16 in. waferboard exterior	2 in. spiral nails @ 6 in. o/c at edges and 12 in. elsewhere
2	no	1 in. Glasclad exterior	as per manufacturer's instruction
3	yes	none	none
4*	yes	none	none
5	no	7/16 in. waferboard exterior	2 in. spiral nails @ 3 in. o/c at edges and 6 in. elsewhere
6	yes	none	interior drywall nails 4 in. o/c
7	no	2-2X6 in. studs placed perpendicular to studs at door opening	3-1/2 in. spiral at 8 in. o/c
8	no	1/2 in. exterior gypsum board	1-1/8 in. drywall screws at 12 in.o/c
9**	no	1/2 in. exterior gypsum board	1-1/8 in. drywall screws for steel studs at 12 in. o/c

* moisture content of studs at construction was greater than 28%.
** steel studs at 16 in. o/c

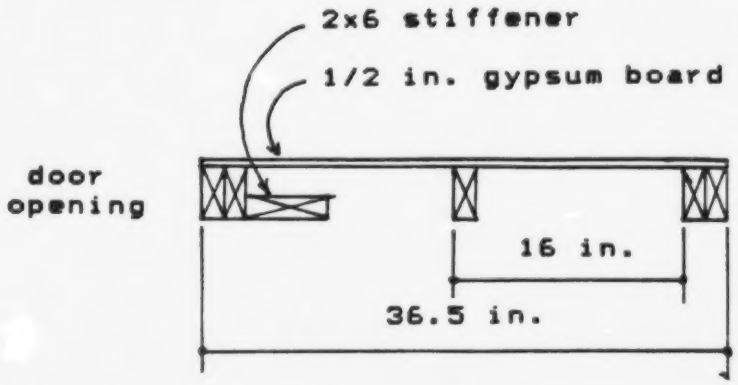

Figure 2. Cross-section through test wall showing extra stud.

5.0 RESULTS AND DISCUSSION

The load at a door jamb separation of 3/8 and 1/2 inch as well as the maximum load and the separation at maximum load are listed in Table 3 in descending order of resistance. The gap at maximum load is also shown with the class rating based on the criteria in ASTM F476 and the type of failure. The plot for each specimen is shown in Appendix A. The data for specimen 4C was lost due to an error in programming the recorder.

Three types of failures were evident. The first was bottom plate shear, an example of which is shown in Figure 3, where the bottom of the wall on the lock side shows excessive slip with respect to the subfloor. The second type, shown in Figure 4, is panel shear in which the exterior sheathing shears over the stud frame. The last general type of failure was a local failure in the nailed connection between sheathing and frame at lock height. This latter failure type, if the blocking was tight, extended to the lines of nails in the studs farther from the door lock. An example of this local lock height failure is shown in Figure 5.

Table 3. Resistance against jamb spreading at two gaps with security class and failure description: in descending order of resistance

TYPE	#	LOAD [kN] @9.5 [mm]	@12.7 [mm]	@MAX	DEF. [mm]	CLASS	FAILURE
double nailed waferboard	5A	16.0	17.0	18.7	21.6	30	bottom plate
	5B	13.2	14.4	16.3	19.6	20	shear
	5C	14.2	16.7	18.1	17.2	30	
waferboard	1A	12.1	13.4	15.0	18.0	20	bottom plate
	1B	12.4	15.9	19.4	18.4	20	shear and
	1C	18.8	F	21.7	9.4	20	panel shear
doubled nailed interior gypsum board	6A	10.9	12.5	13.7	14.7	20	bottom plate
	6B	10.0	12.3	12.9	15.6	20	shear
	6C	9.5	12.0	13.9	19.0	20	
exterior gypsum board	8A	9.2	8.9	9.6	7.6	20	bottom plate
	8B	9.7	10.8	11.6	13.8	20	shear and
	8C	8.9	10.1	11.7	20.0	20	panel shear
extra stud	7A	5.6	9.2	13.1	19.8	F	shear at
	7B	10.0	10.9	11.8	15.6	20	bottom of
	7C	7.7	9.1	14.0	16.8	10	lock height
blocking /dry construction	3A	6.9	7.6	8.1	14.8	10	interior
	3B	6.8	8.3	9.5	16.4	10	gypsum panel
	3C	8.3	9.2	9.3	14.4	20	shear
blocking /wet construction	4A	5.9	6.7	8.3	18.4	F	interior panel
	4B	5.5	6.4	7.3	19.2	F	shear & local
	4C	-	-	-	-	-	lock height nail joint failure
Glasclad	2A	4.8	5.1	5.3	14.8	F	lock height nail
	2B	5.9	5.9	6.1	7.2	F	joint failure in
	2C	7.3	7.3	7.5	7.6	F	adjacent stud
steel stud	9A	F	F	6.6	2.7	F	exterior gypsum
	9B	F	F	5.4	6.8	F	panel and
	9C	F	F	5.1	-2.0	F	torsion in stud

F : failed

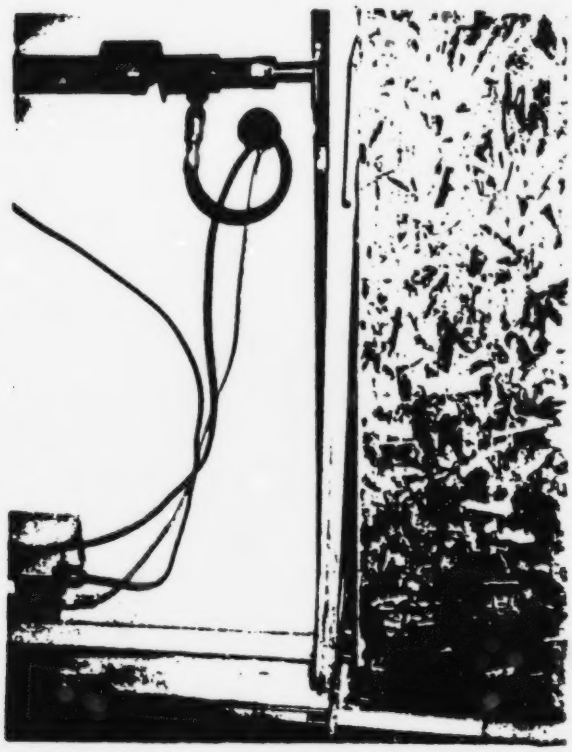

Figure 3. An example of bottom plate shear failure.

Figure 4. An example of a panel shear failure.

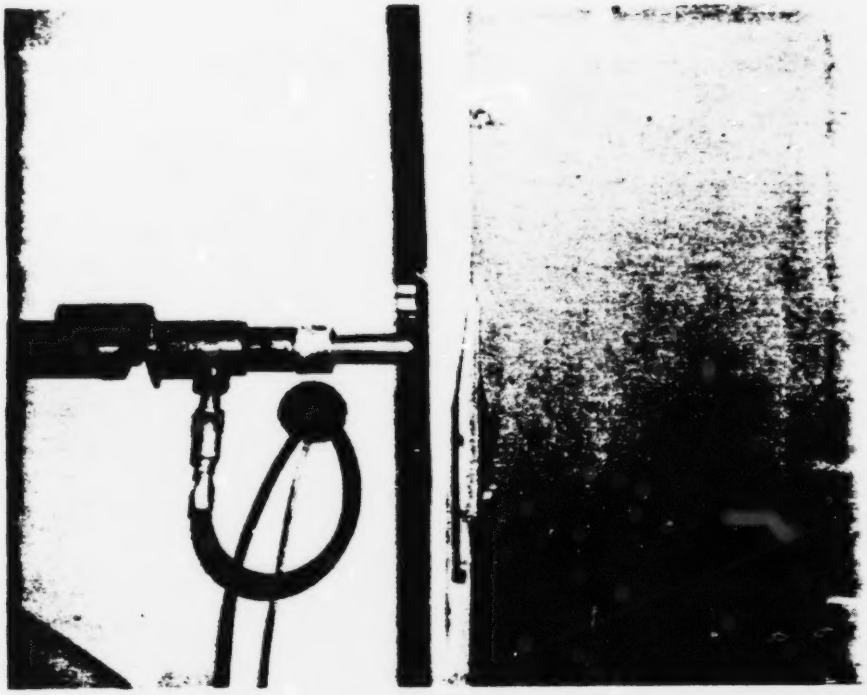

Figure 5. An example of local lock height failure in gypsum board.

Where failure was due to bottom plate shear, the 2-3.5-in. spiral nails that were used to fasten the bottom plate to the waferboard and lumber plate were reinforced with the addition of 2 extra nails in the plate on each side of the door. Where possible, the wall was retested. Only double nailed walls, type 5 and 6, failed in bottom plate shear alone while the others, type 1 and 8 exhibited some panel shear failure and this shows that on short walls, less than 3 feet on each side of the door, the weakest point is not the wall panel but the wall to floor connection. In order to increase the security class rating, consideration must be given to improving this connection or to restrict the length of wall.

Except for type #4, the mean moisture content of the Balsam fir studs at test was 10% with a coefficient of variation (COV) of 12%. The moisture content of spruce studs were 11% with a COV of 6.5%. The average moisture content of the Balsam fir studs in the type #4 walls at test was 21.5% whereas the moisture content of the blocking was about 14%. In the case of the spruce studs in specimen 4C, the moisture content was about 13%.

After 29 days of drying, the rate of drying in the Balsam fir studs in the type #4 walls was extremely slow so, in view of the schedule, it was decided to proceed with the test.

Measurements were taken of the dimensions at block height of the width of the studs and the stud cavity both at construction and at time of test for resistance to jamb spreading. The maximum shrinkage was found in the spruce studs to be about 6% at a moisture content of 13%. This results in an increase in the stud cavity of about 2.5 mm (0.1 in.), however this is by no means uniform across the face of the stud due to the warp that occurs during drying. It was observed that in cases where the blocking remains tight, the nail joint failures in the gypsum board occur not only along the stud closest but also along the central stud and the farthest stud from the lock.

The effect of wood quality or species was quite variable. Significant differences in the resistance at a 9.5 mm gap were found only in sets #1, #2 and #7. This may be due to the mode of failure that governed in each case. Although each wall specimen was built with one of three species or grades of lumber, the bottom plate beneath the waferboard floor strip was spruce lumber of substantially the same quality. Consequently, the lateral shear strength of the connection between the wall and the "floor" was approximately the same in each case. Thus, where failure occurred in bottom plate shear, the effect of the species or grade on the resistance against door jamb spreading could not be seen.

The significance of the difference in resistance to jamb spreading between any two wall types, shown in Table 4, was tested on the basis of the difference in resistance at both gaps and of the maximum resistance shown in Table 3. The Glasclad wall type (#2) is assumed equivalent to a wall with no sheathing or blocking.

When the walls were first tested, the studs on walls without exterior sheathing rotated in torsion due to the eccentricity of the applied load to the unsymmetrical construction of the wall. In effect, the gap closed initially and then increased as the load was increased. The rotation of the jamb also caused it, after repeated loading, to fail; so, it was replaced. In addition, the hinge side jamb was reinforced with a steel angle over three-quarters of its length and the attachment of the jamb to the threshold was reinforced with a short steel strap. These measures were judged not to affect the results since the lock-side jamb was not stiffened or strengthened. Their main purpose was to reduce the rotation of the jamb and to prevent failure in the jamb or connections.

Cedar shims were installed at lock height in each specimen. The rotation of the stud made measurement of the deformation of the shim extremely difficult. Due to the eccentric nature of the load application, it became senseless to make further measurements of the shim deformation with this apparatus. It was apparent, however, that as long as it was placed at lock height, the deformation of the shim, whether it was cedar or foam, contributed little to jamb spreading.

Table 4. The effect of various construction details on resistance to jamb spreading.

EFFECT	DIFFERENCE	MEAN N	COV [kN]	t [%]	SIGNIFICANCE	at 5% level
waferboard	#1 - #2	8	10.1	27.3	10.36	S
double nailed waferboard	#5 - #2	9	9.93	21.5	13.96	S
steel studs	#8 - #9	3	5.27	37.5	4.62	S
extra studs	#7 - #2	9	4.02	63.8	4.70	S
exterior gypsum	#8 - #2	9	3.92	29.3	10.23	S
double nailed interior gypsum	#6 - #3	9	3.77	34.6	8.68	S
blocking	#3 - #2	9	2.09	38.6	7.77	S
dry - wet	#3 - #4	6	1.18	71.6	3.42	S
wet blocking	#4 - #2	6	1.17	97.4	2.52	NS

S: significant NS: not significant
N: number of differences in analysis
t: student's "t" statistic
COV: coefficient of variation

6.0 CONCLUSIONS

1. Of the construction options that were tested, exterior waferboard sheathing had the greatest effect in increasing the resistance to jamb spreading. In this application, it is expected that plywood would perform in a manner similar to waferboard.

2. There appears to be no significant increase in the resistance of a wall sheathed with waferboard when the nail spacing is decreased by half from normal spacing. This may be due to the

mode of failure. In walls adequately prevented from excessive slip between the bottom plate and floor, the difference in resistance may be significant.

3. The use of flexible sheathing products, such as Glasclad, alone do not provide sufficient protection against jamb spreading.

4. The use of blocking alone, whether installed wet or dry, has a small or no effect on the resistance to jamb spreading, but it was enough to increase the resistance to a level that just exceeded the minimum required for the lowest security class of 10. It is likely that the walls constructed with wet lumber (set #4) would receive a security class of 10 if they were tested at the same moisture content as the others.

5. In walls with exterior gypsum board sheathing, the wood framed walls had a mean increase in resistance of 5.3 kN over steel framed walls. This was sufficient to give the wood framed walls a security class of 20 whereas the steel framed walls failed even a security class of 10. This is attributed to the rigidity with which wood studs hold a nail against rotation at the panel and stud interface and which is much greater than that found in a thin steel stud.

6. The use of extra studs perpendicular to those framing the door opening, exterior gypsum board sheathing and reducing the spacing of nails in the interior gypsum board sheathing, all had a mean increase in resistance of about 4 kN which, in 7 specimens of the 9 tested in this group, was sufficient to increase the security class by one level - from 10 to 20.

7. The resistance against jamb spreading of short, strong walls on the lock side of exterior doors is limited by the fastening of the bottom plate to the floor.

7.0 RECOMMENDATIONS

1. For security purposes, in high crime rate areas, the use of waferboard or plywood as exterior sheathing on each side of exterior doors rather than blocking, should be required.

2. The nailing requirements for fastening bottom plates to floors on each side of exterior doors should be increased to at least 4-82 mm nails.

3. Exterior gypsum board sheathing or an extra stud connected to the top and bottom plates with framing brackets should be considered alternatives to increase security in residential areas with low to average crime rates.

8.0 REFERENCES

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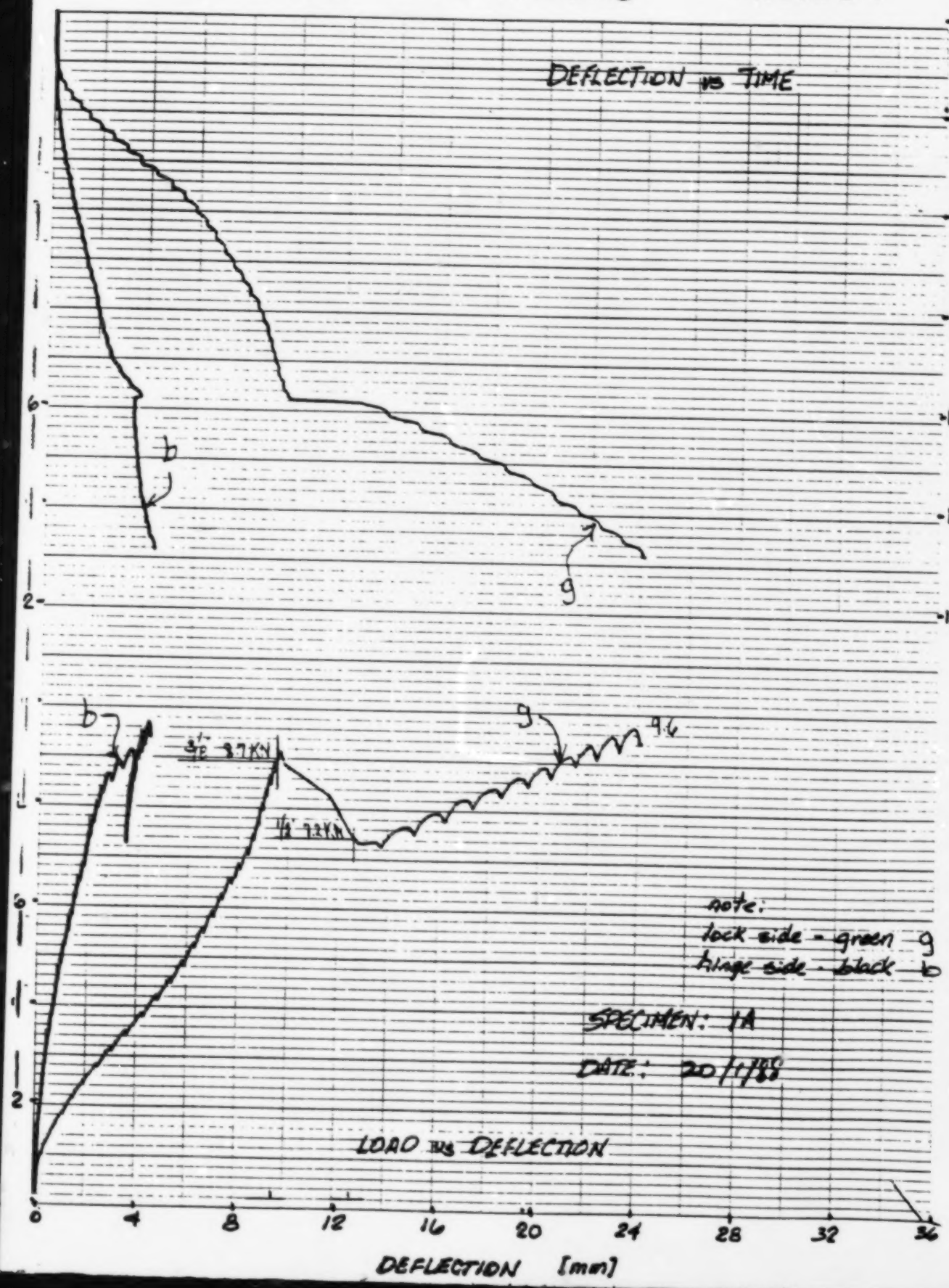
APPENDIX A

PLOTS OF ALL TEST RESULTS

CMHC JAMB SPREADING 4559W514



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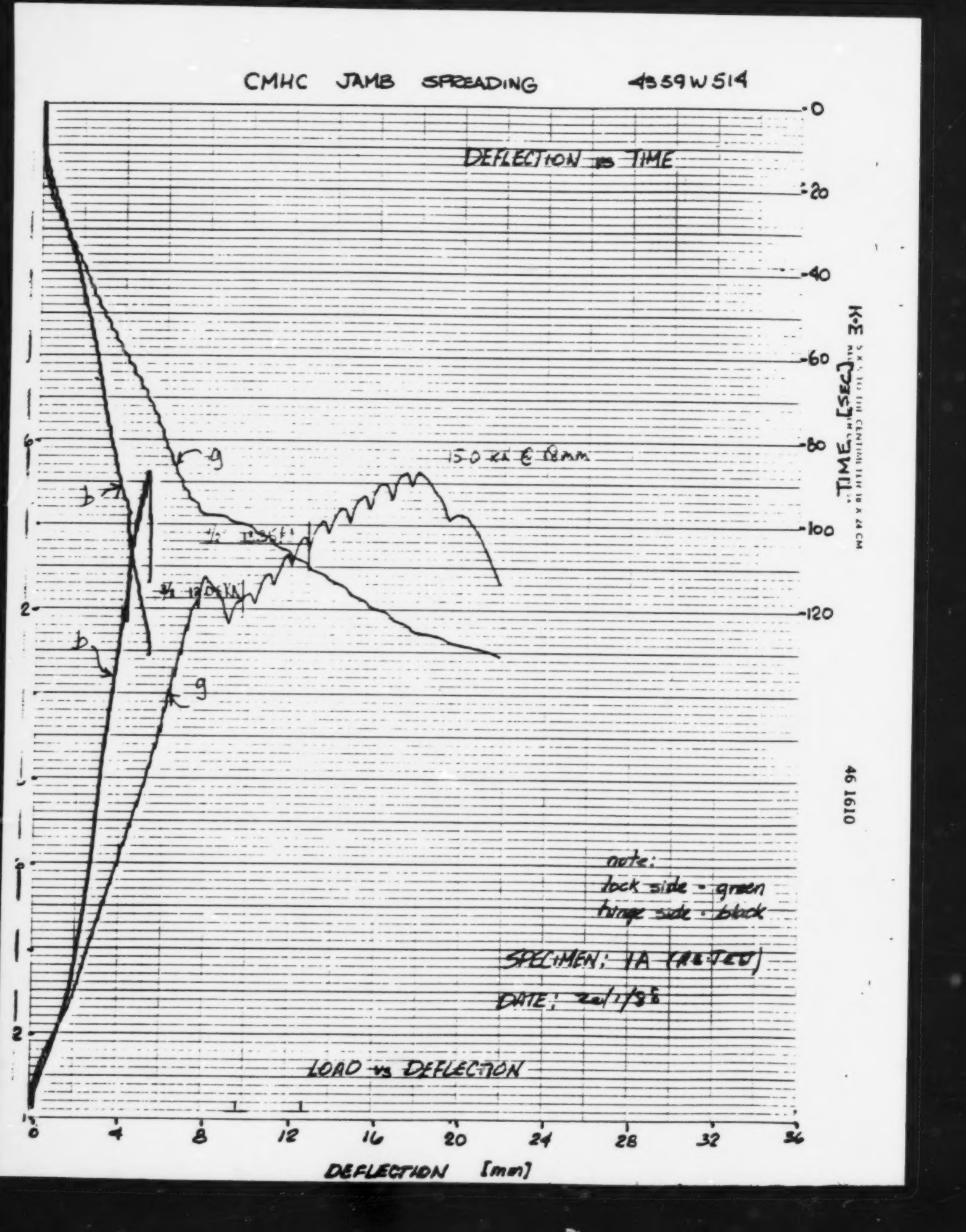
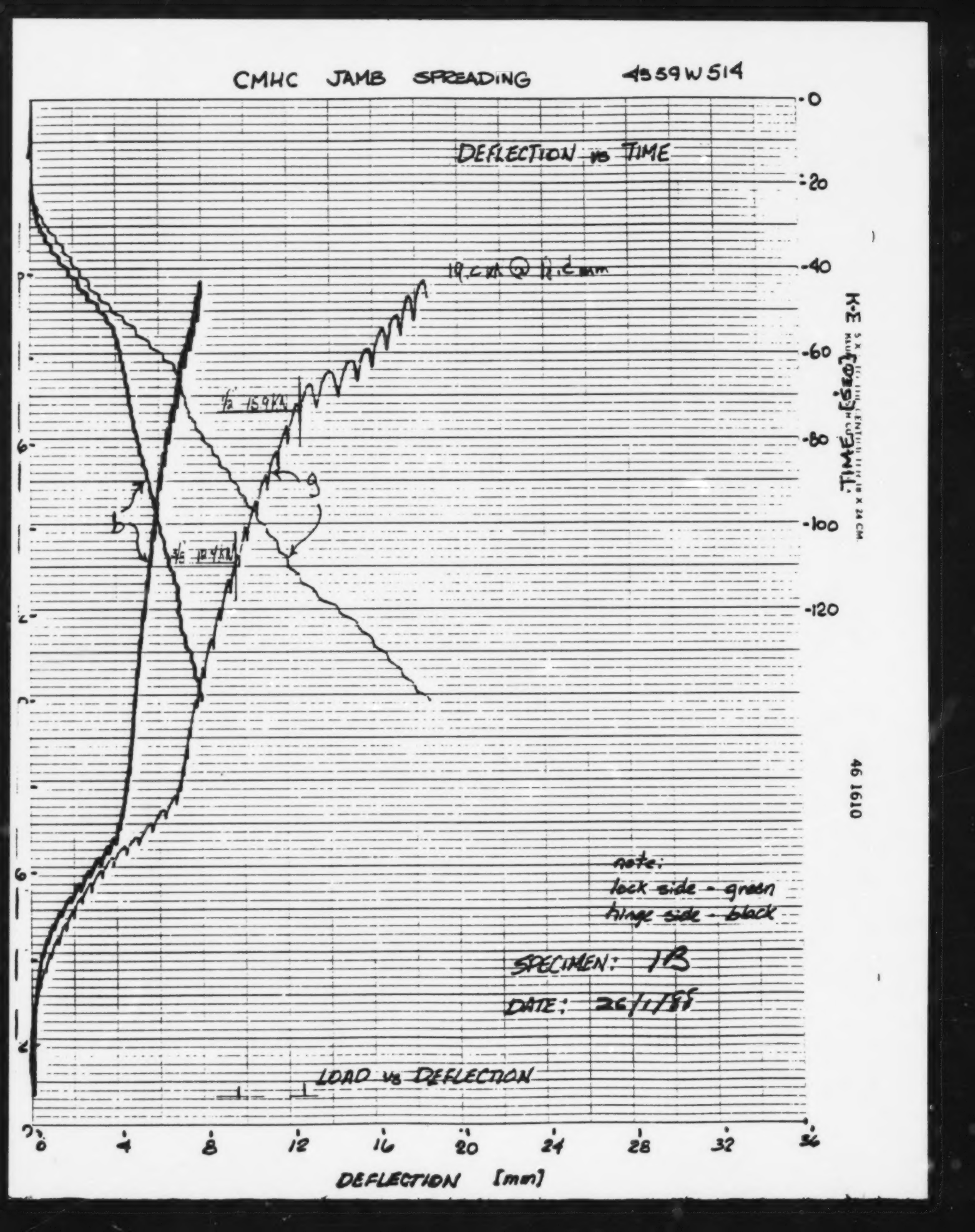
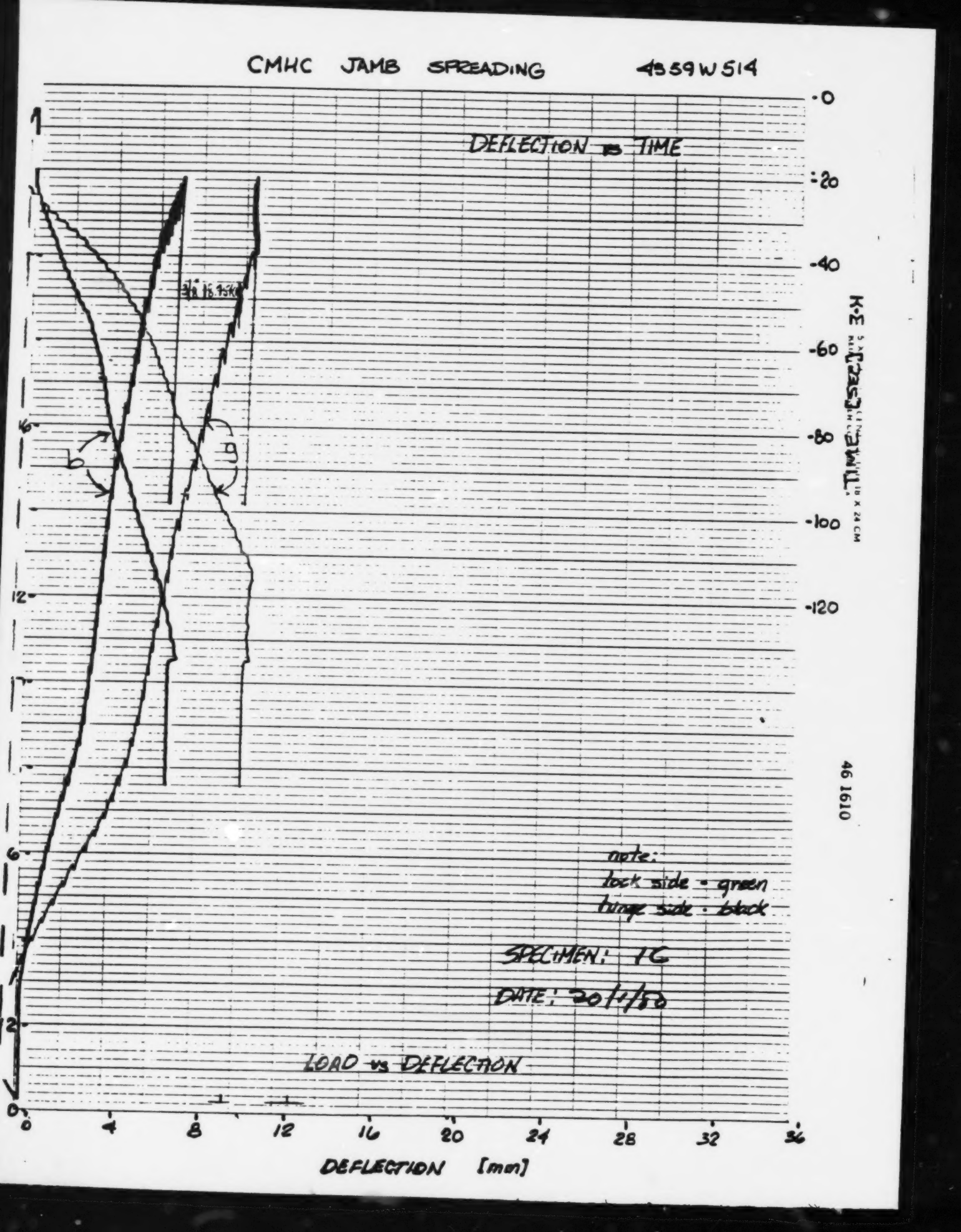
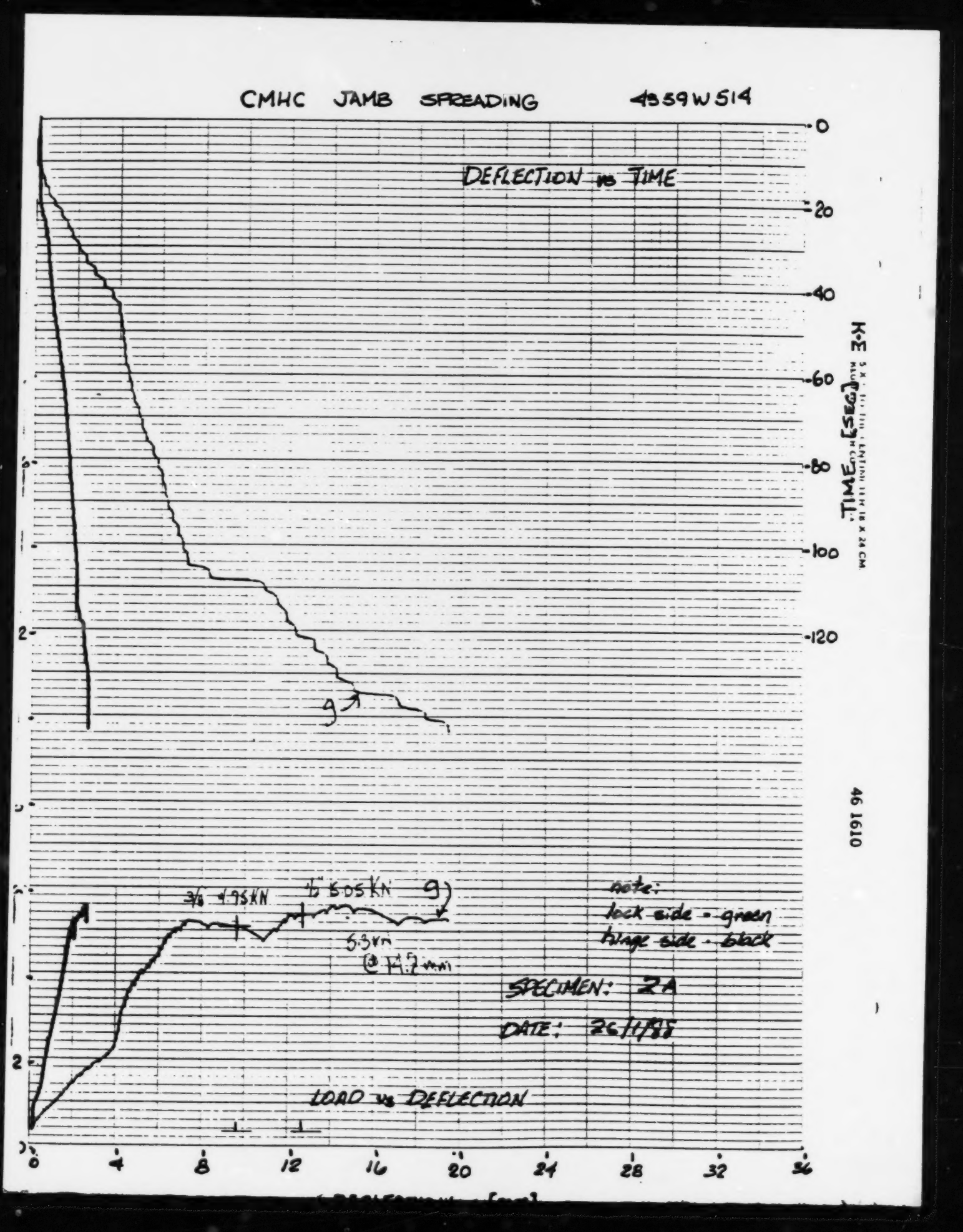
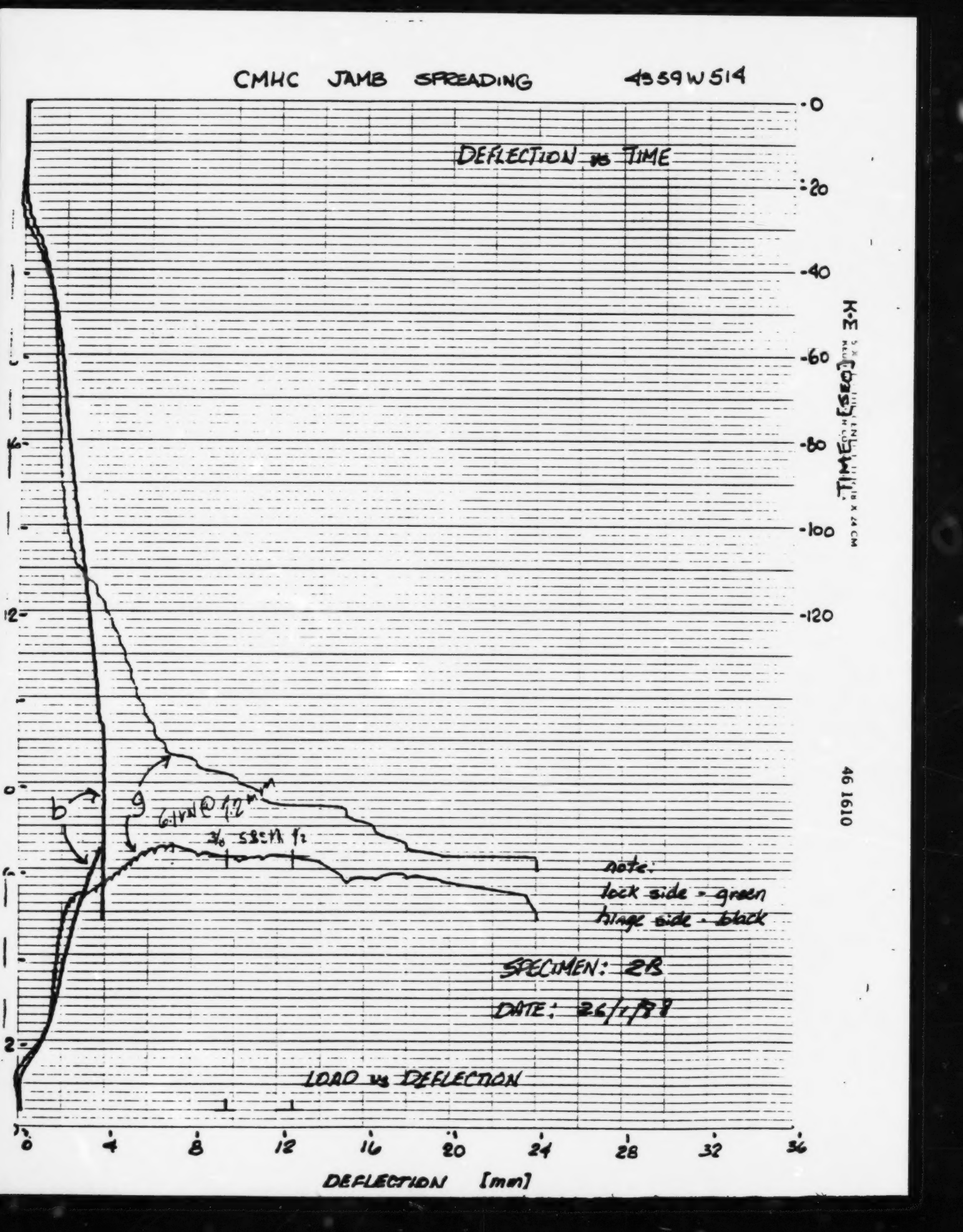
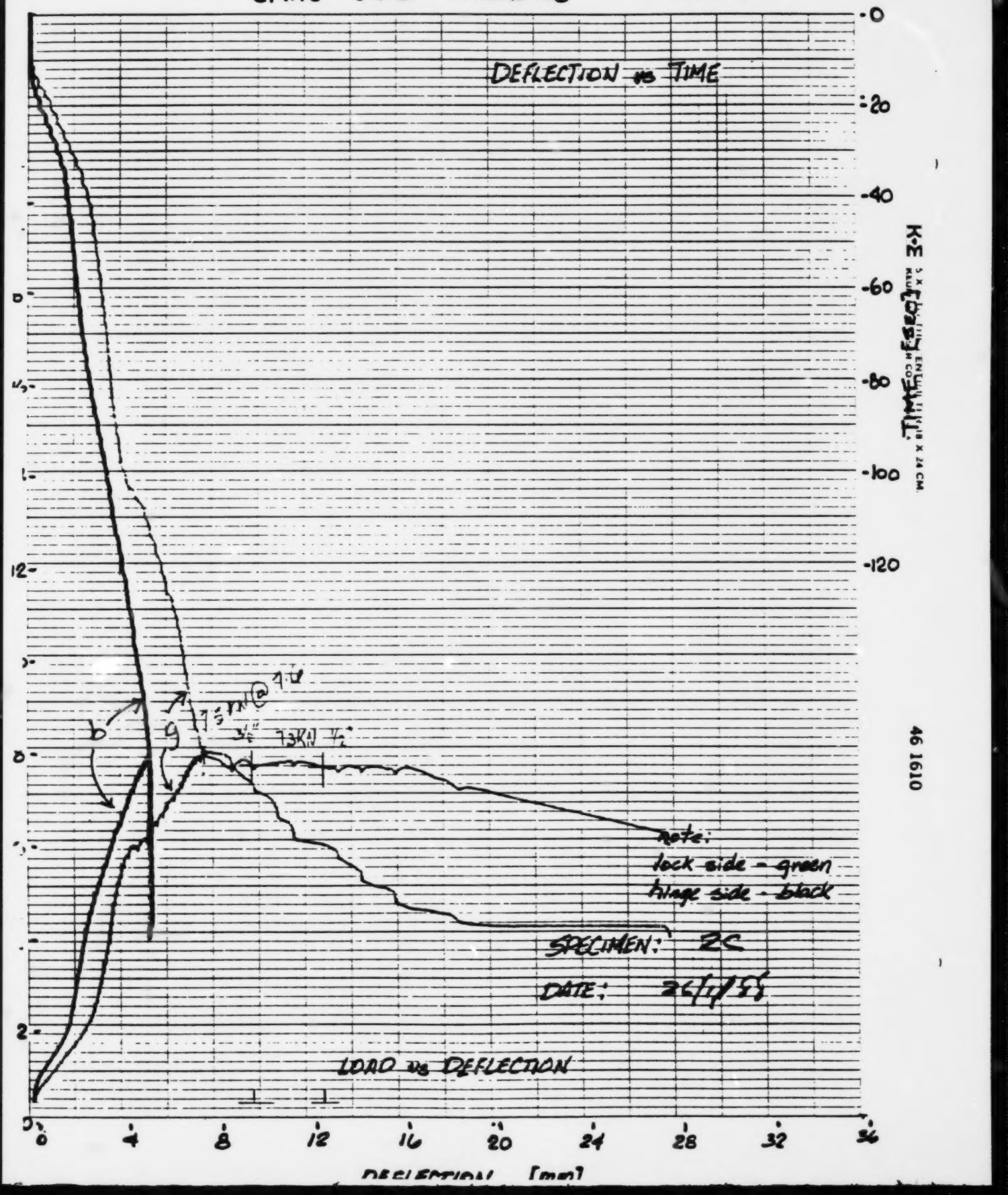

CMHC JAMB SPREADING 4359W514
DEFLECTION vs TIME
TIME [SEC]
0
20
40
60
80
100
120
150 x 1 @ 18mm
g
b
b
g
LOAD vs DEFLECTION
0
4
8
12
16
20
24
28
32
36
DEFLECTION [mm]
note:
lock side - green
hinge side - black
SPECIMEN: 1A (AGED)
DATE: 2d 1/35
46 1610


CMHC JAMB SPREADING
4559W514
DEFLECTION vs TIME
19.c mm @ 11.c mm
½ 15.9 KN
½ 12.4 KN
LOAD vs DEFLECTION
DEFLECTION [mm]
TIME [secs]
0
20
40
60
80
100
120
0
4
8
12
16
20
24
28
32
36
note:
lock side - green
hinge side - black
SPECIMEN: 1B
DATE: 26/1/85
46 1610

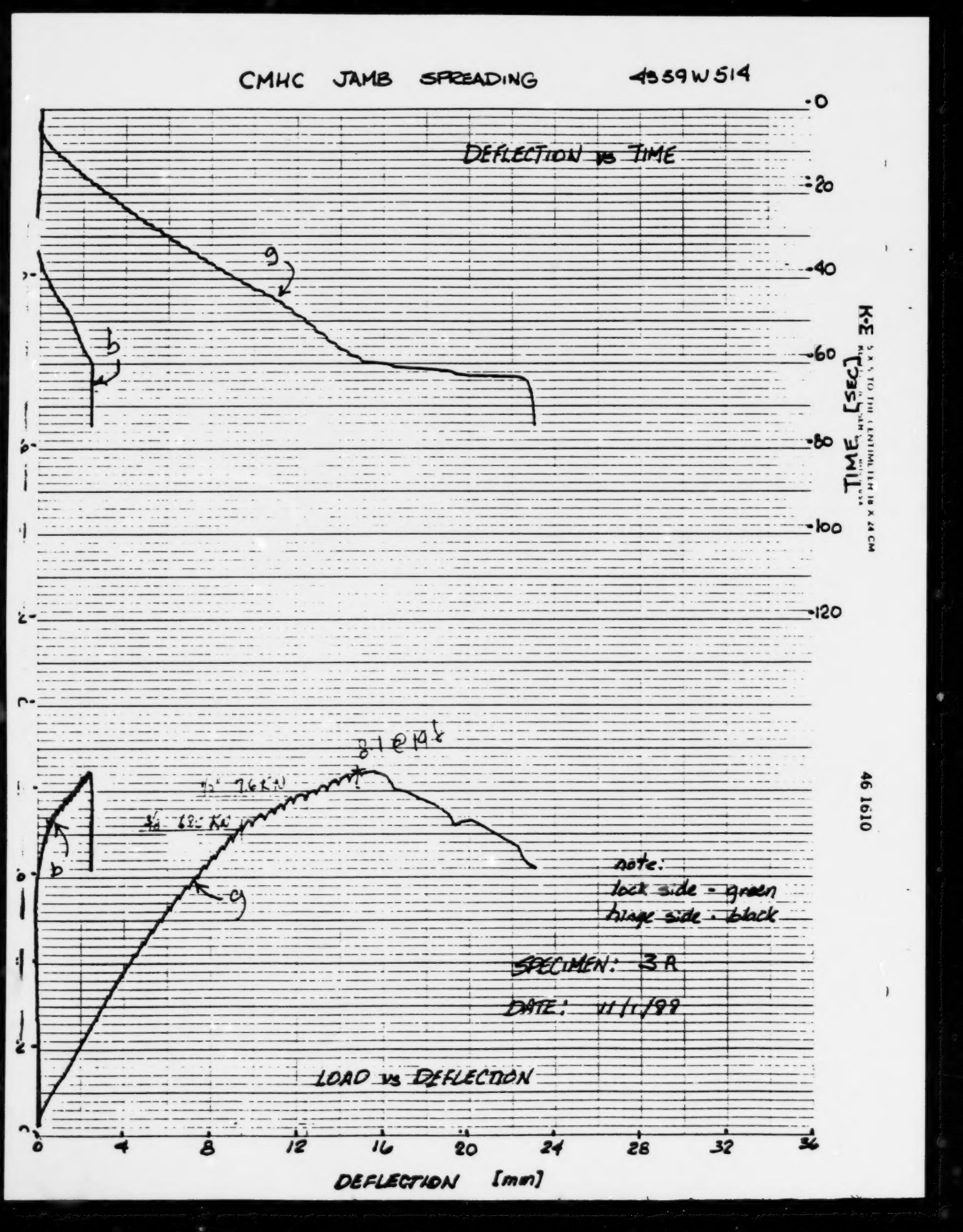

CMHC JAMB SPREADING 4359W514
DEFLECTION vs TIME
LOAD vs DEFLECTION
DEFLECTION [mm]
0
4
8
12
16
20
24
28
32
36
-0
-20
-40
-60
-80
-100
-120
note:
lock side - green
hinge side - black
SPECIMEN: 1C
DATE: 30/1/80
46 1610


CMHC JAMB SPREADING 4359W514
DEFLECTION vs TIME
TIME (secs)
0
20
40
60
80
100
120
3/8 4.95KN
½ 5.05KN
5.3mm
@ 14.5 mm
note:
lock side - green
hinge side - black
SPECIMEN: 2A
DATE: 26/11/88
LOAD vs DEFLECTION
0
4
8
12
16
20
24
28
32
36
K-E
46 1610

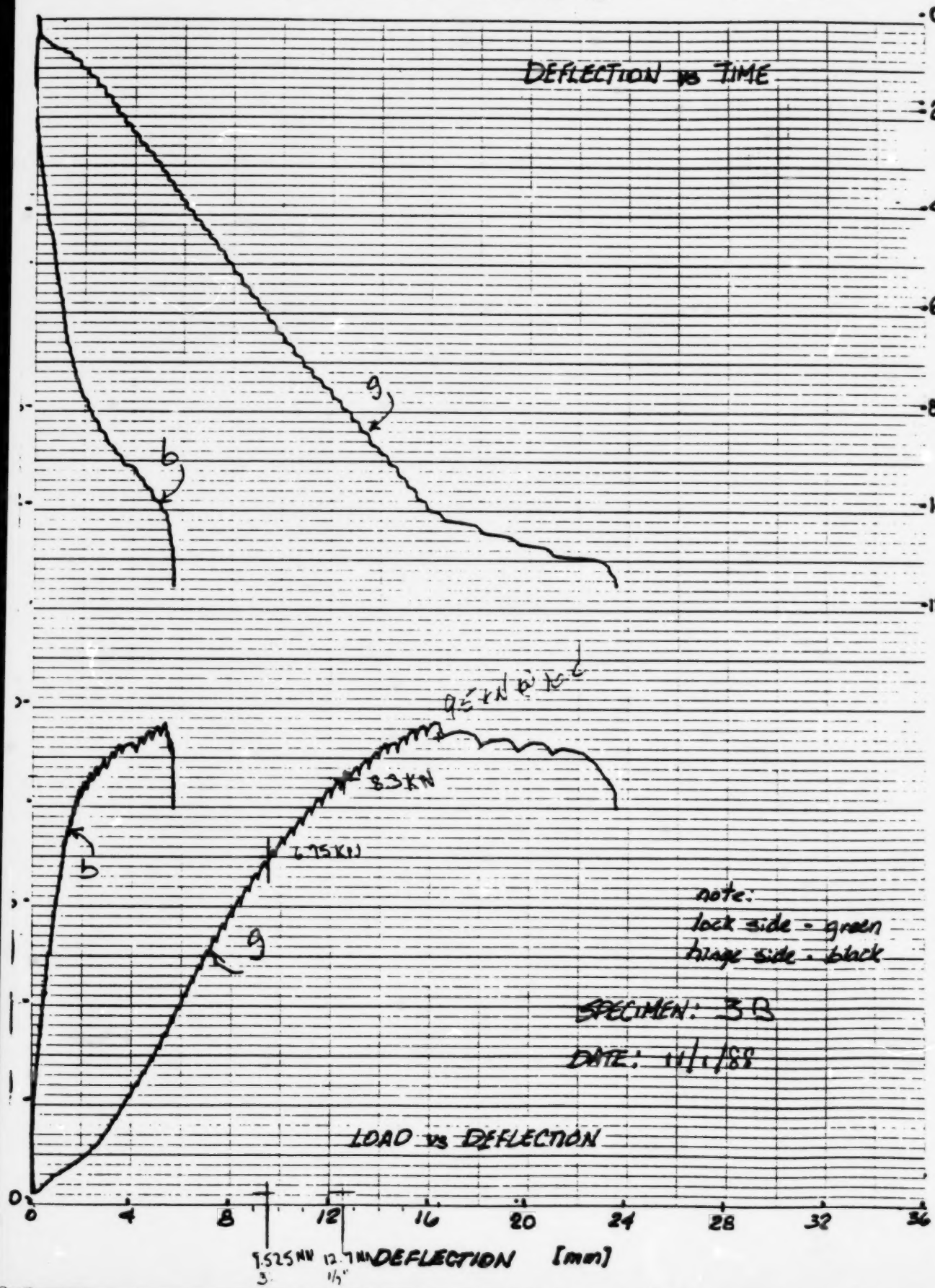

CMHC JAMB SPREADING
4359W514
DEFLECTION vs TIME
TIME [sec]
0
20
40
60
80
100
120
K-E
46 1610
b
g
note:
lock side - green
hinge side - black
SPECIMEN: 2B
DATE: 26/1/88
LOAD vs DEFLECTION
0
4
8
12
16
20
24
28
32
36
DEFLECTION [mm]


CMHC JAMB SPREADING
4359W514
DEFLECTION vs TIME
LOAD vs DEFLECTION
DEFLECTION [mm]
note:
lock side - green
hinge side - black
SPECIMEN: 2C
DATE: 26/1/88
46 1610
K-E

CMHC JAMB SPREADING 4359W514



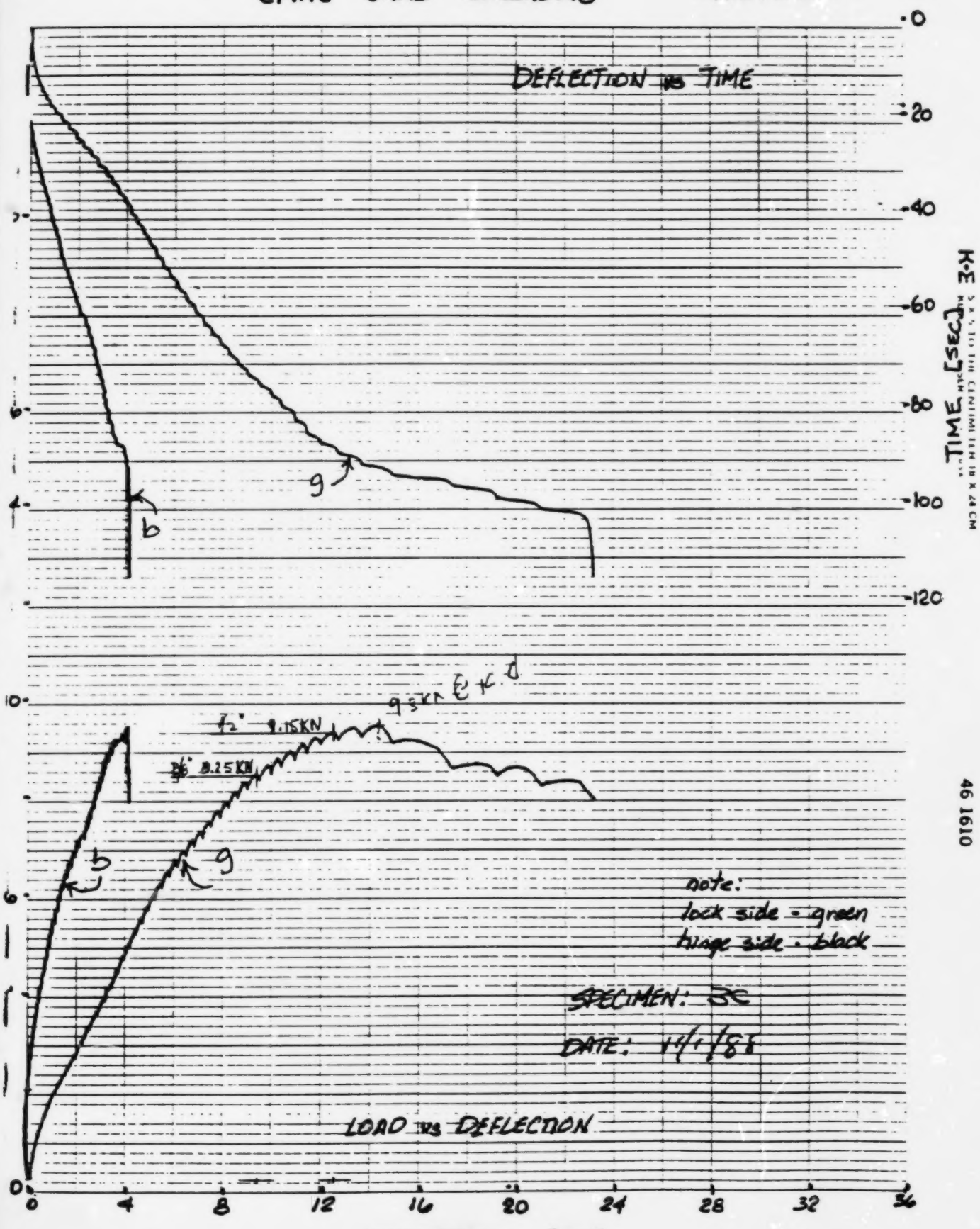
CMHC JAMB SPREADING 4359W514



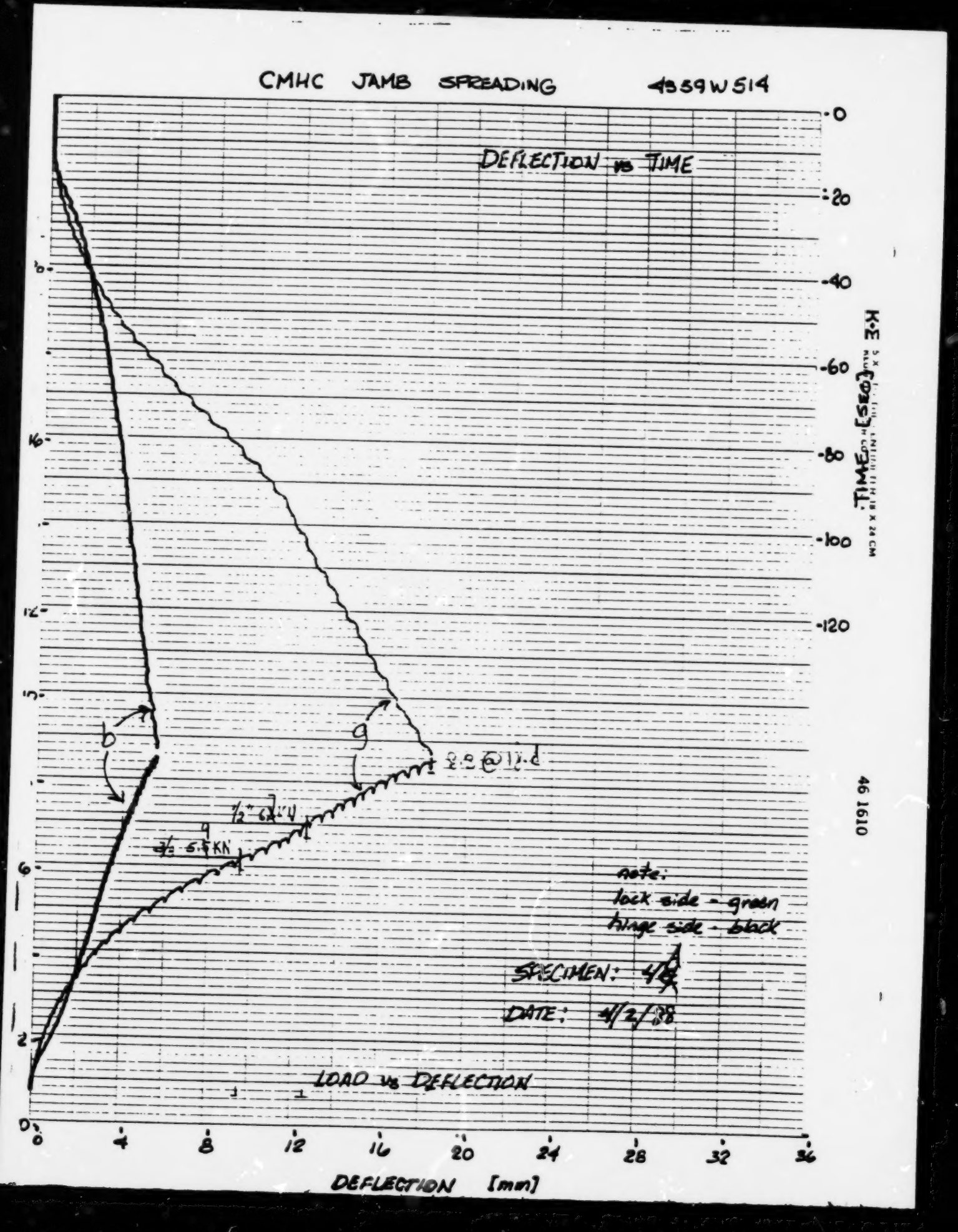
KE 5 X 5 TO THE CENTIMETER 10 X 25 CM

46 1610

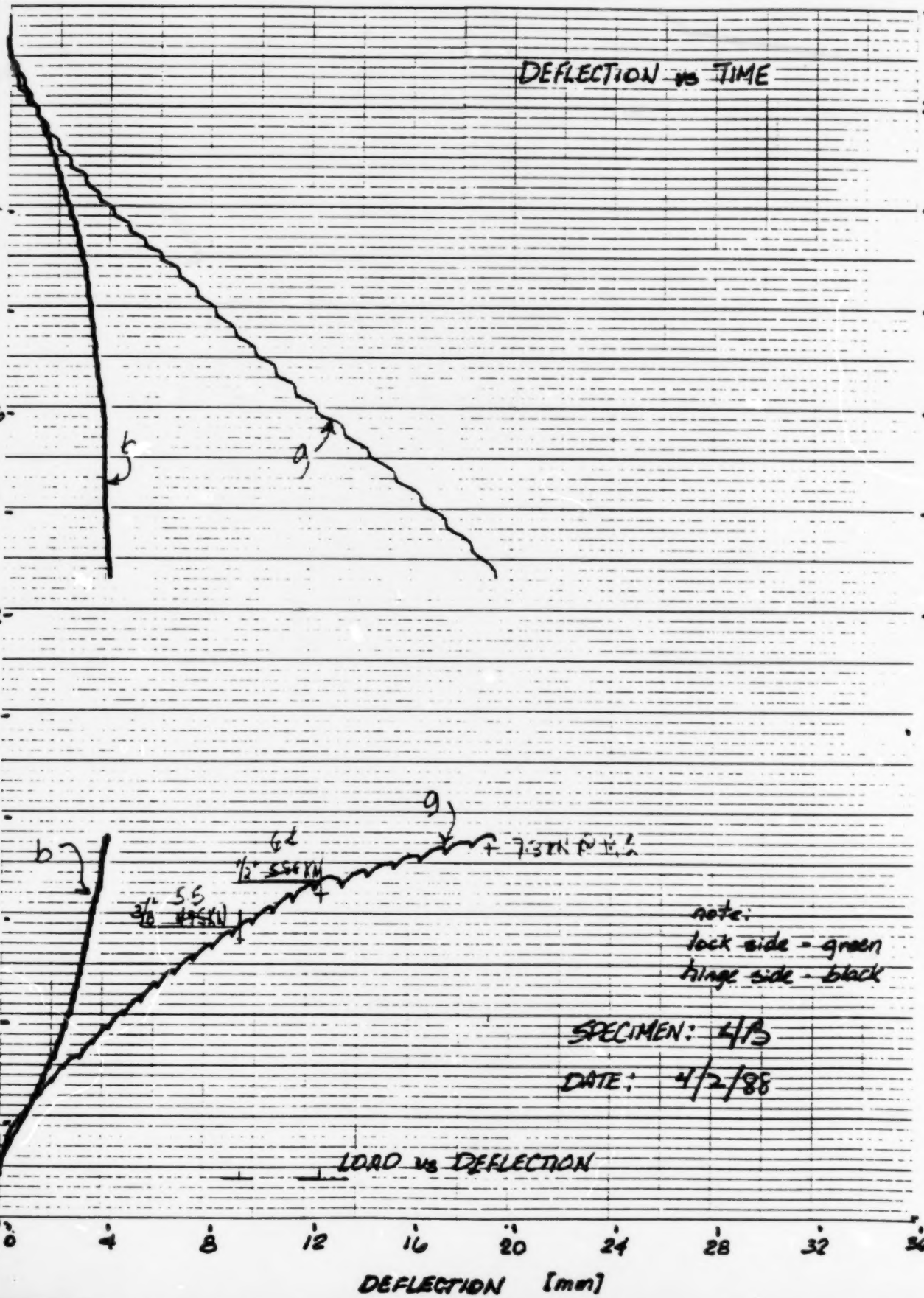
CMHC JAMB SPREADING 4359W514



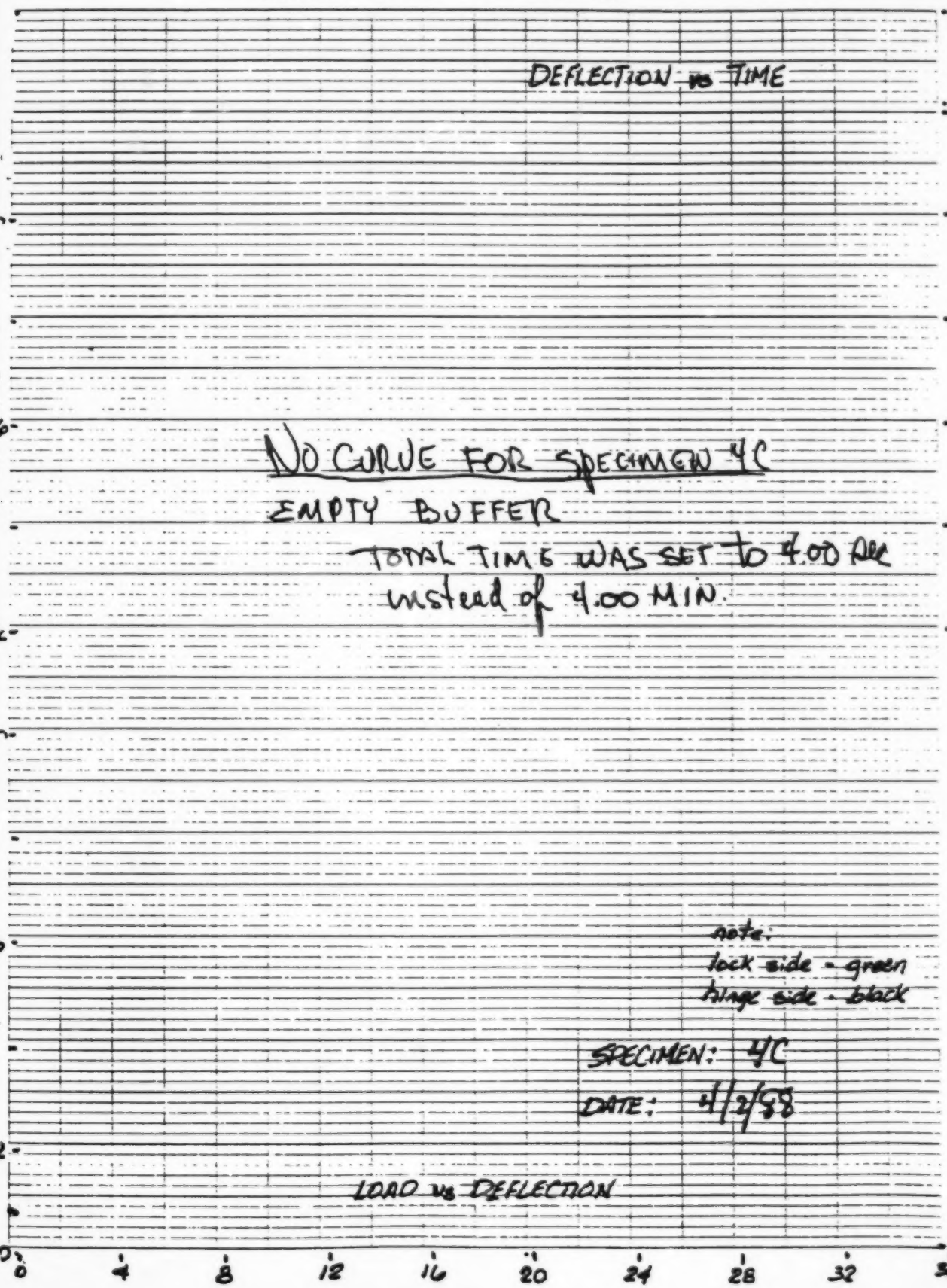
K+E 3-K
5 X 5 TO THE CENTIMETER 18 X 44 CM
46 1610


CMHC JAMB SPREADING
4359W514
DEFLECTION vs TIME
TIME [sec]
0
20
40
60
80
100
120
LOAD vs DEFLECTION
DEFLECTION [mm]
0
4
8
12
16
20
24
28
32
36
b
g
½" @ 4"
½" @ 5.5 KN
note:
lock side - green
hinge side - black
SPECIMEN: 4/A
DATE: 4/2/88
K+E
46 1610

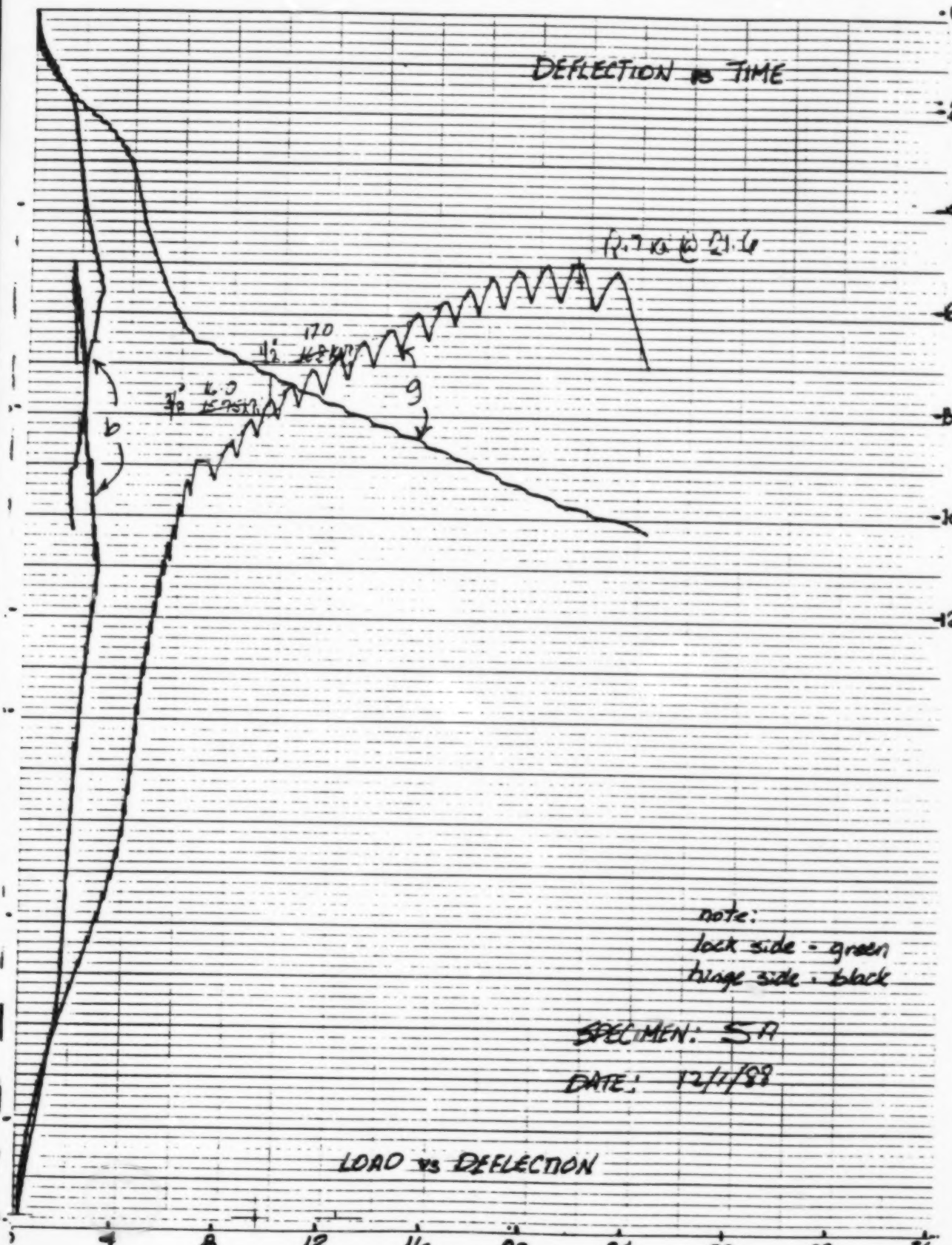
CMHC JAMB SPREADING 4559W514



CMHC JAMB SPREADING 4359W514

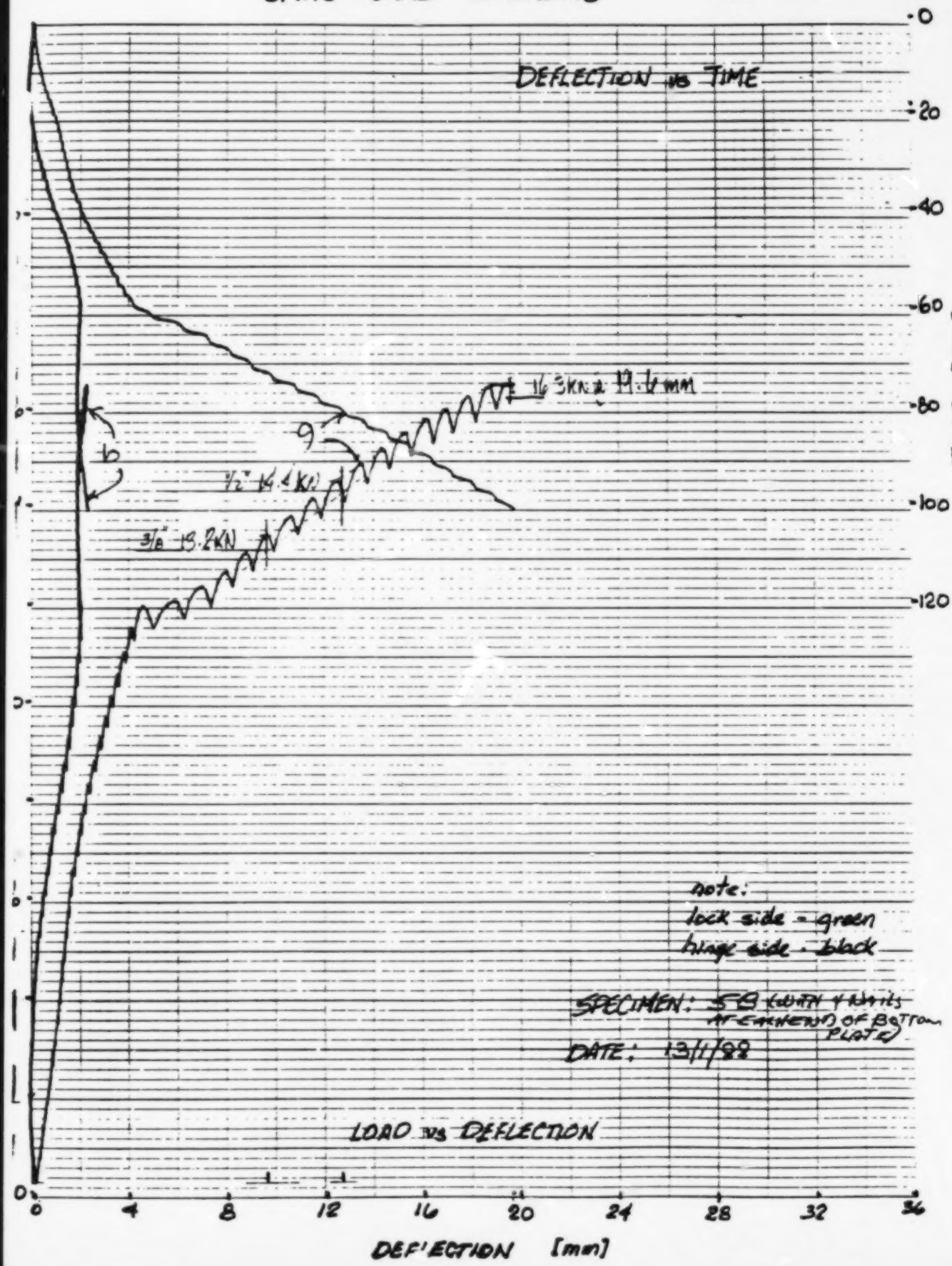


CMHC JAMB SPREADING 4359W514



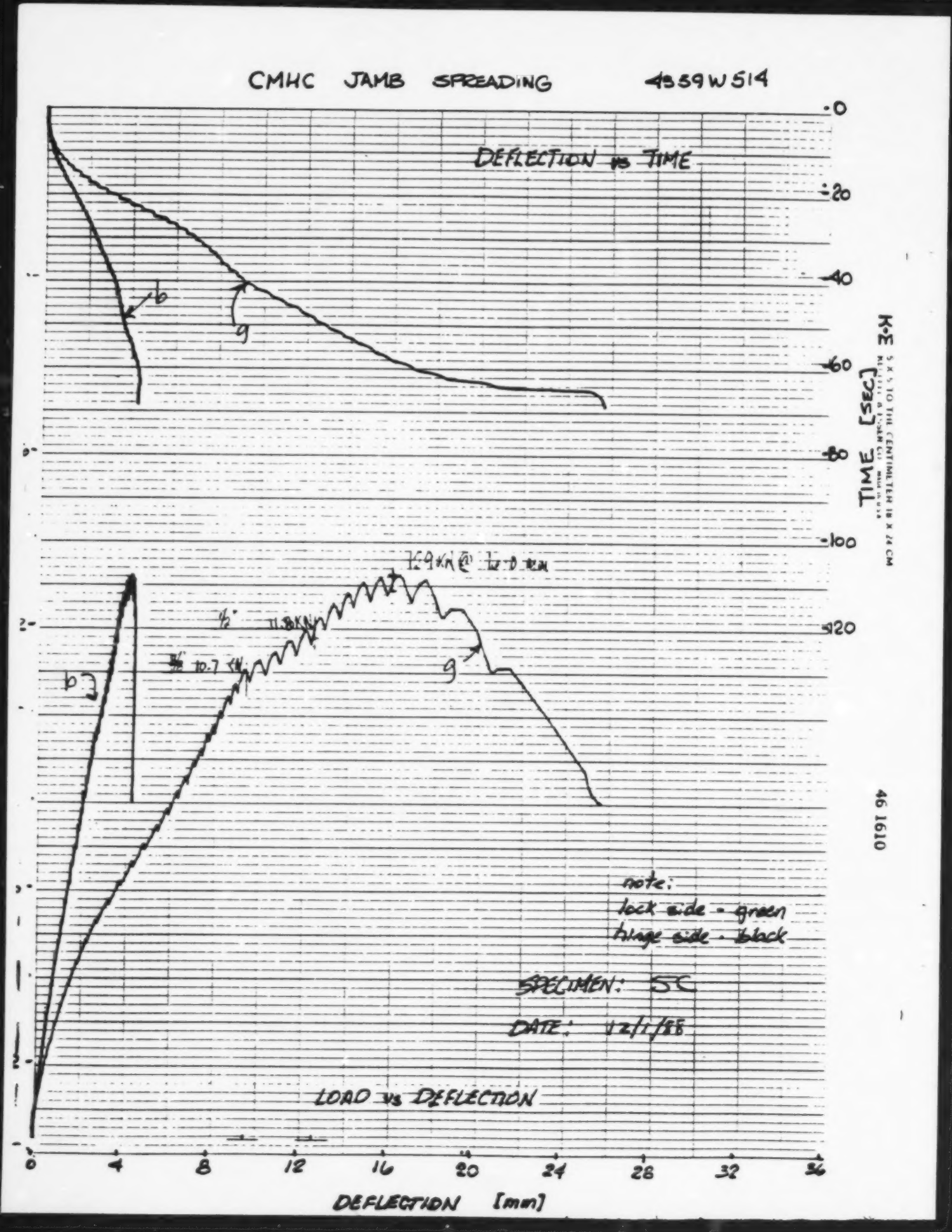
46 1610

CMHC JAMB SPREADING 4359W514

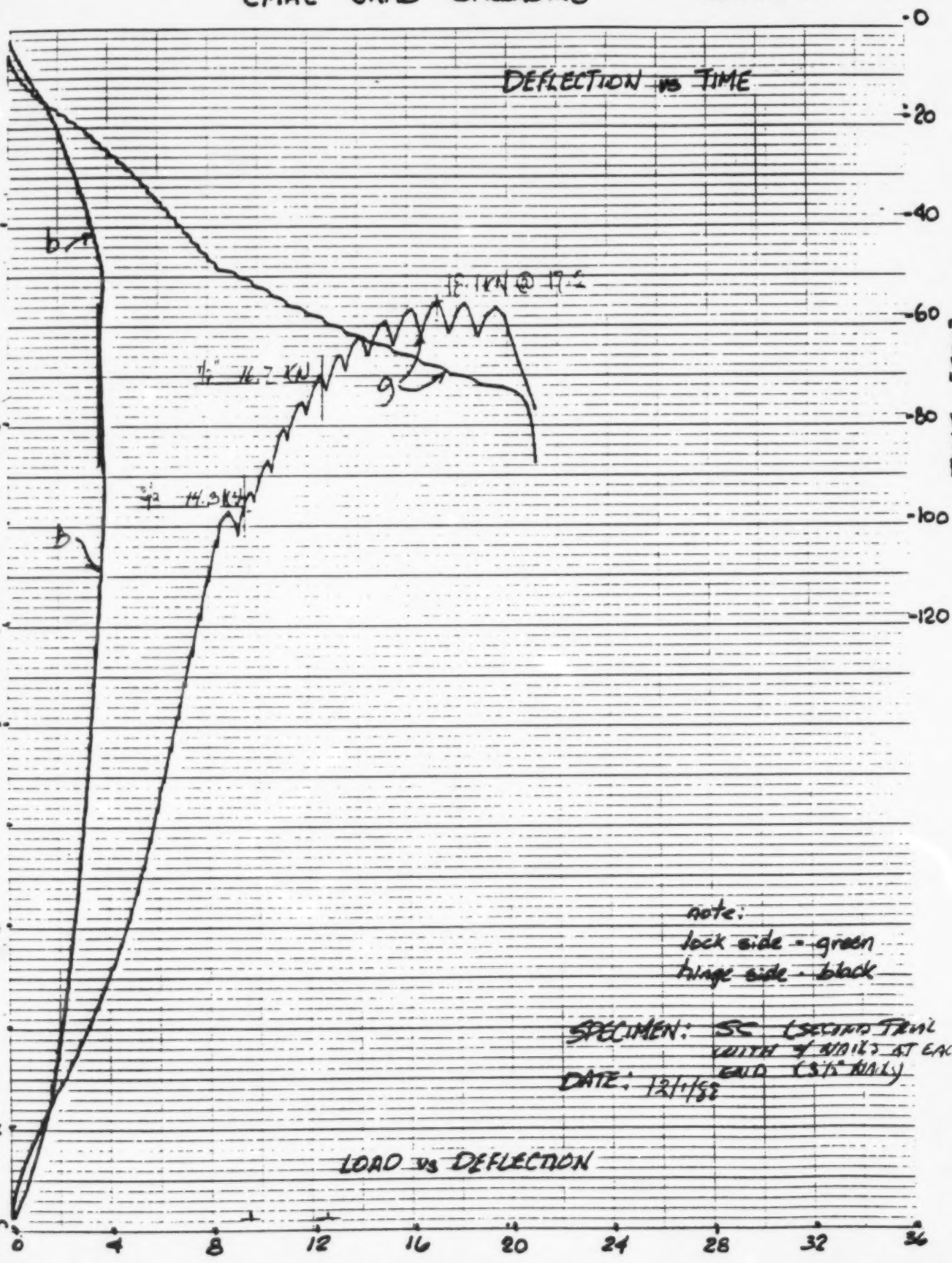


46 1610

CMHC JAMB SPREADING 4359W514



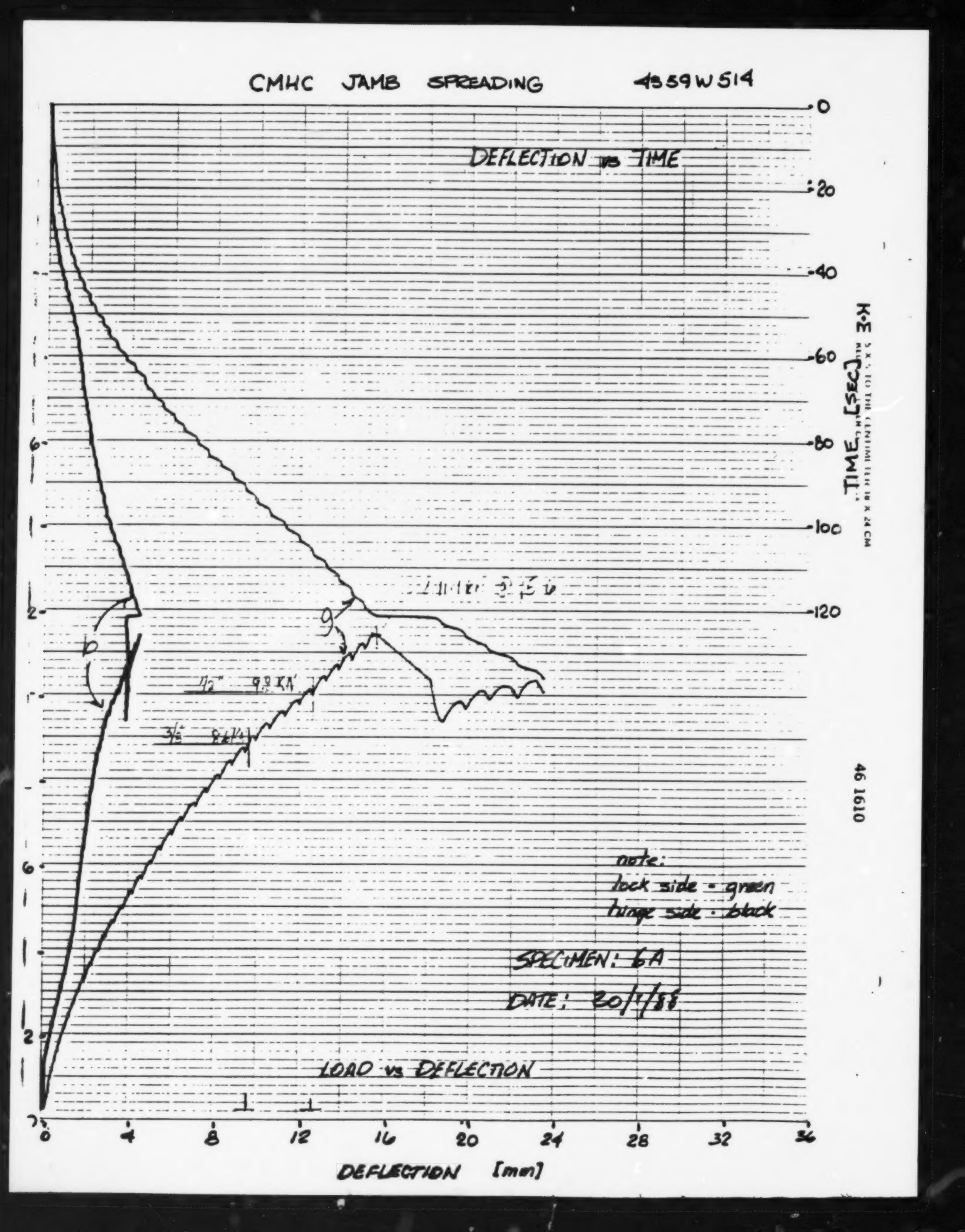
CMHC JAMB SPREADING 4359W514

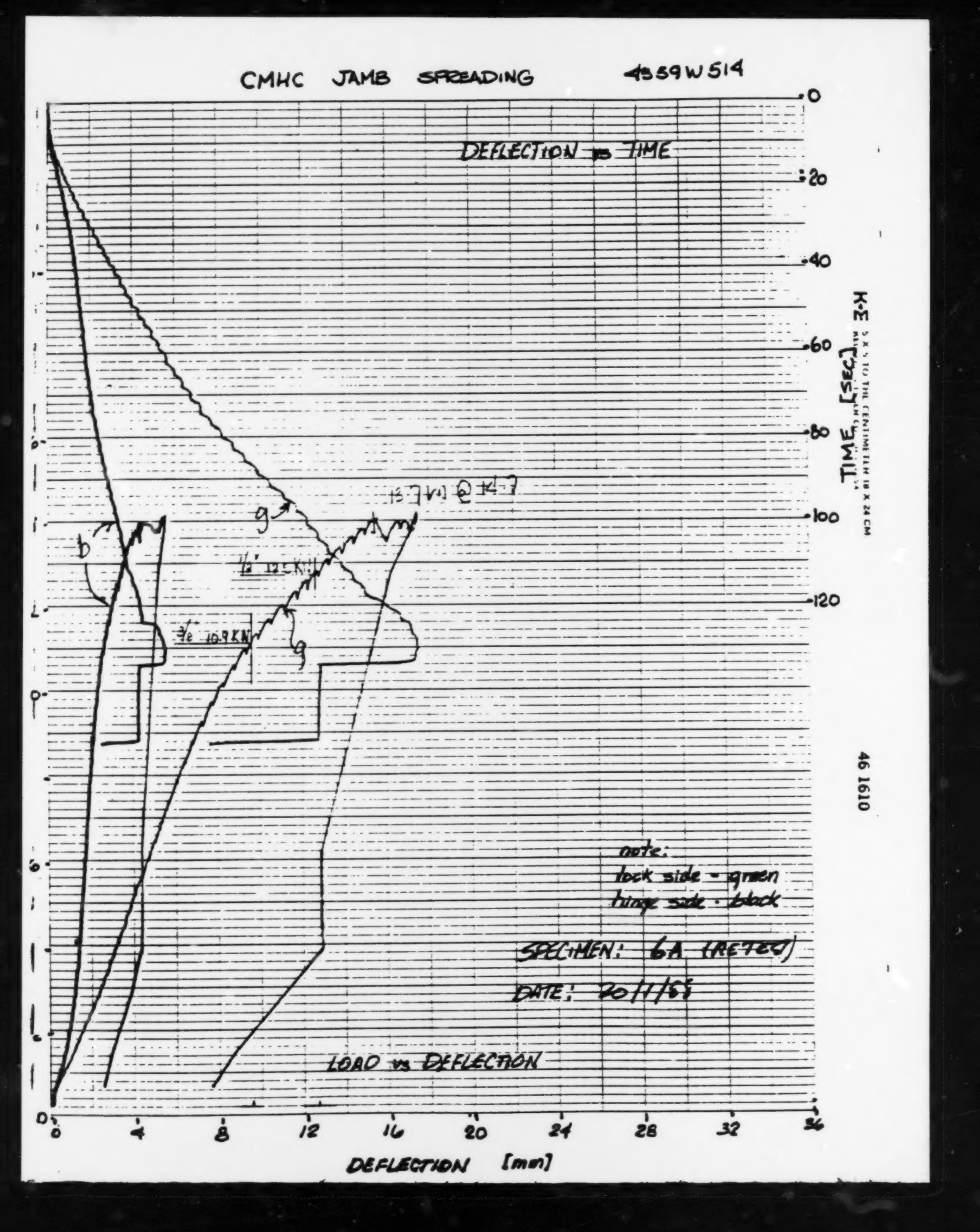


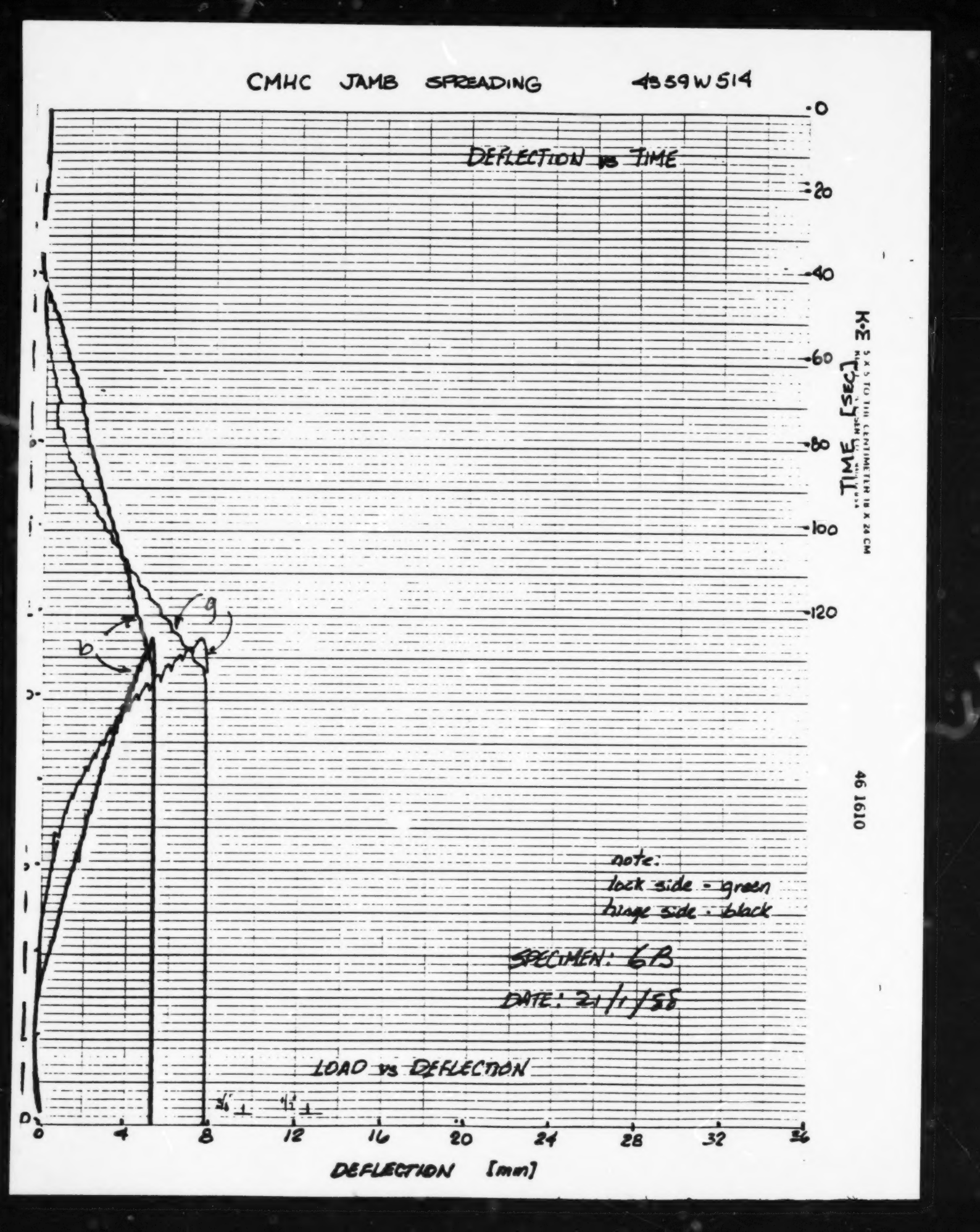
46 1610

note:
lock side - green
hinge side - black

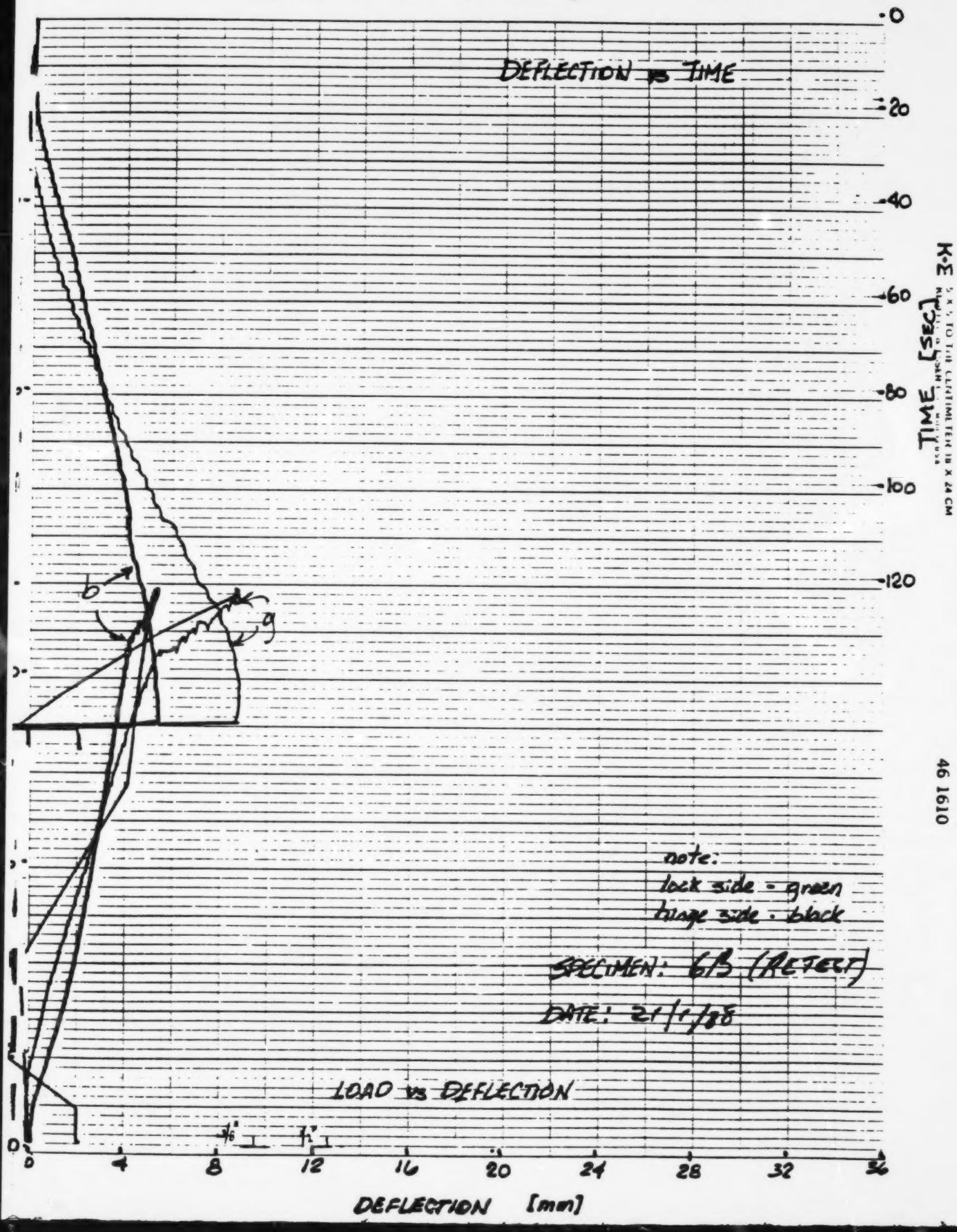
SPECIMEN: SC (SECOND TRIAL WITH 4 NAILS AT EACH END (3½" NAILS)
DATE: 12/1/58


CMHC JAMB SPREADING
4359W514
DEFLECTION vs TIME
TIME [SEC]
0
20
40
60
80
100
120
LOAD vs DEFLECTION
0
4
8
12
16
20
24
28
32
36
DEFLECTION [mm]
note:
lock side - green
hinge side - black
SPECIMEN: 6A
DATE: 30/4/86
46 1610


CMHC JAMB SPREADING
4359W514
DEFLECTION vs TIME
TIME [sec]
0
20
40
60
80
100
120
K+E 5 X 5 TO THE CENTIMETER 10 X 25 CM
46 1610
b
g
½' 12.5 KN
⅜ 10.9 KN
note:
lock side - green
hinge side - black
SPECIMEN: 6A (RETEST)
DATE: 20/11/85
LOAD vs DEFLECTION
0
4
8
12
16
20
24
28
32
36
DEFLECTION [mm]

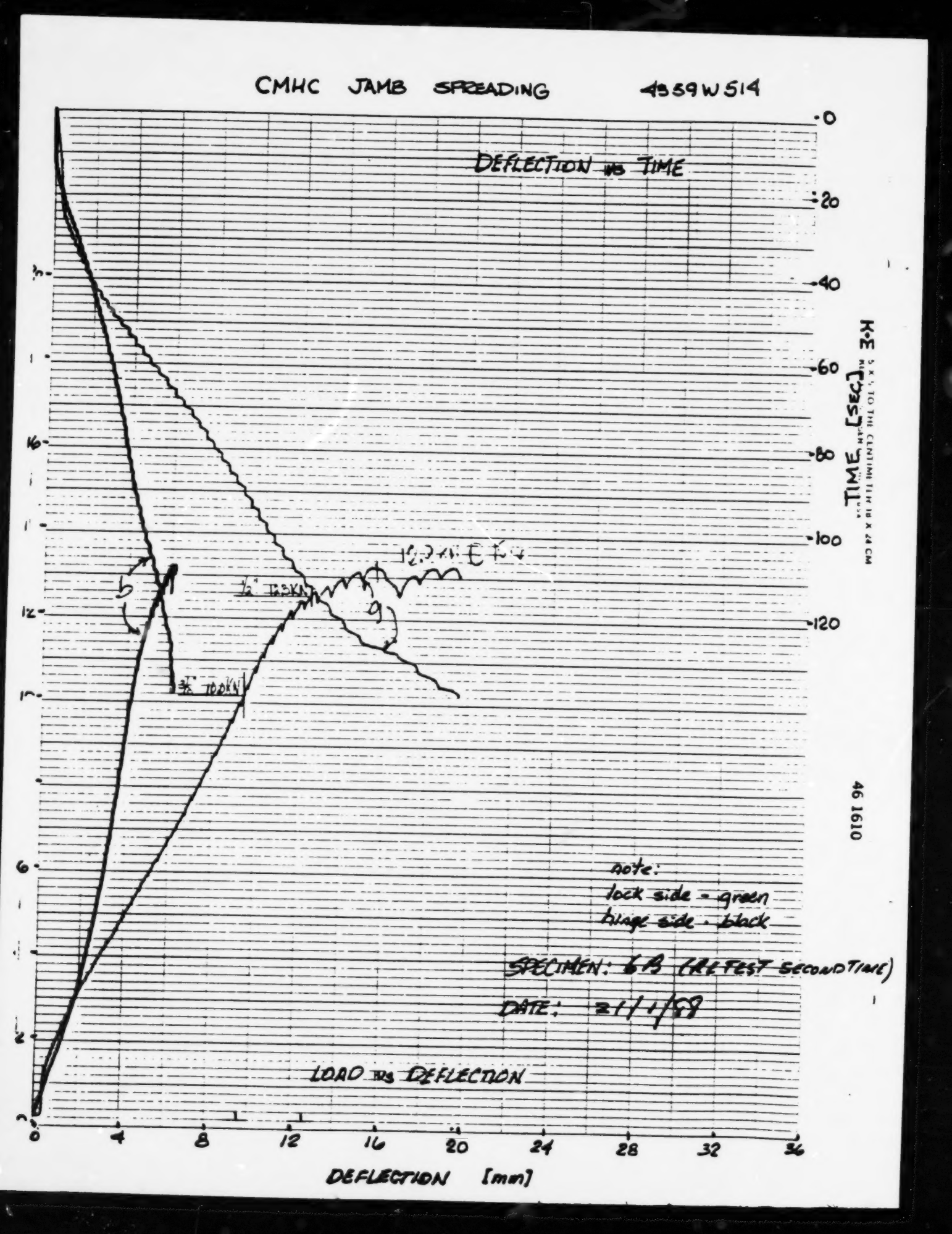

CMHC JAMB SPREADING 4359W514
DEFLECTION vs TIME
TIME [sec]
0
20
40
60
80
100
120
K+E 5 X 5 TO THE CENTIMETER 18 X 24 CM
46 1610
a
b
note:
lock side = green
hinge side = black
SPECIMEN: 6B
DATE: 21/1/58
LOAD vs DEFLECTION
0
4
8
12
16
20
24
28
32
36
DEFLECTION [mm]

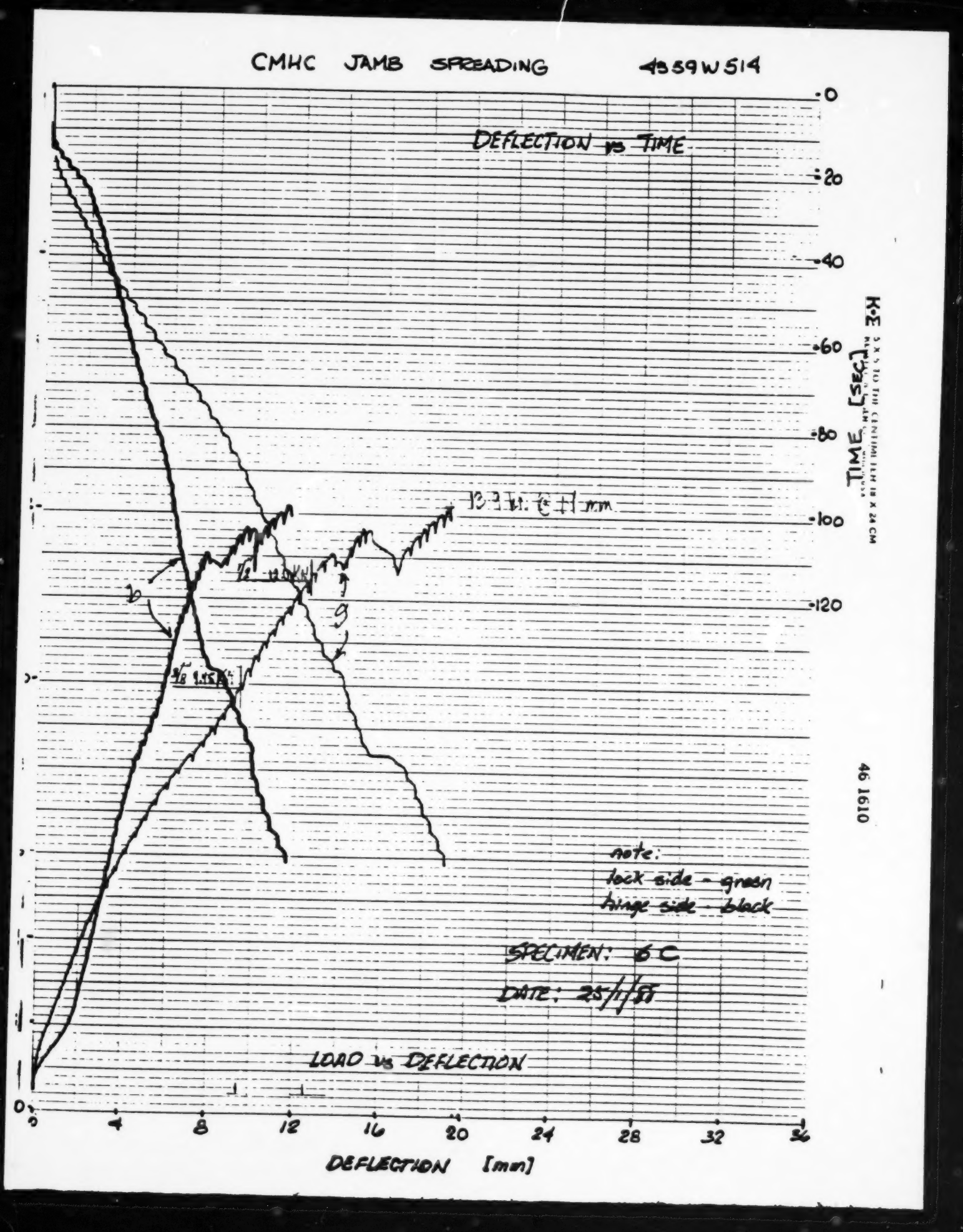
CMHC JAMB SPREADING 4559W514



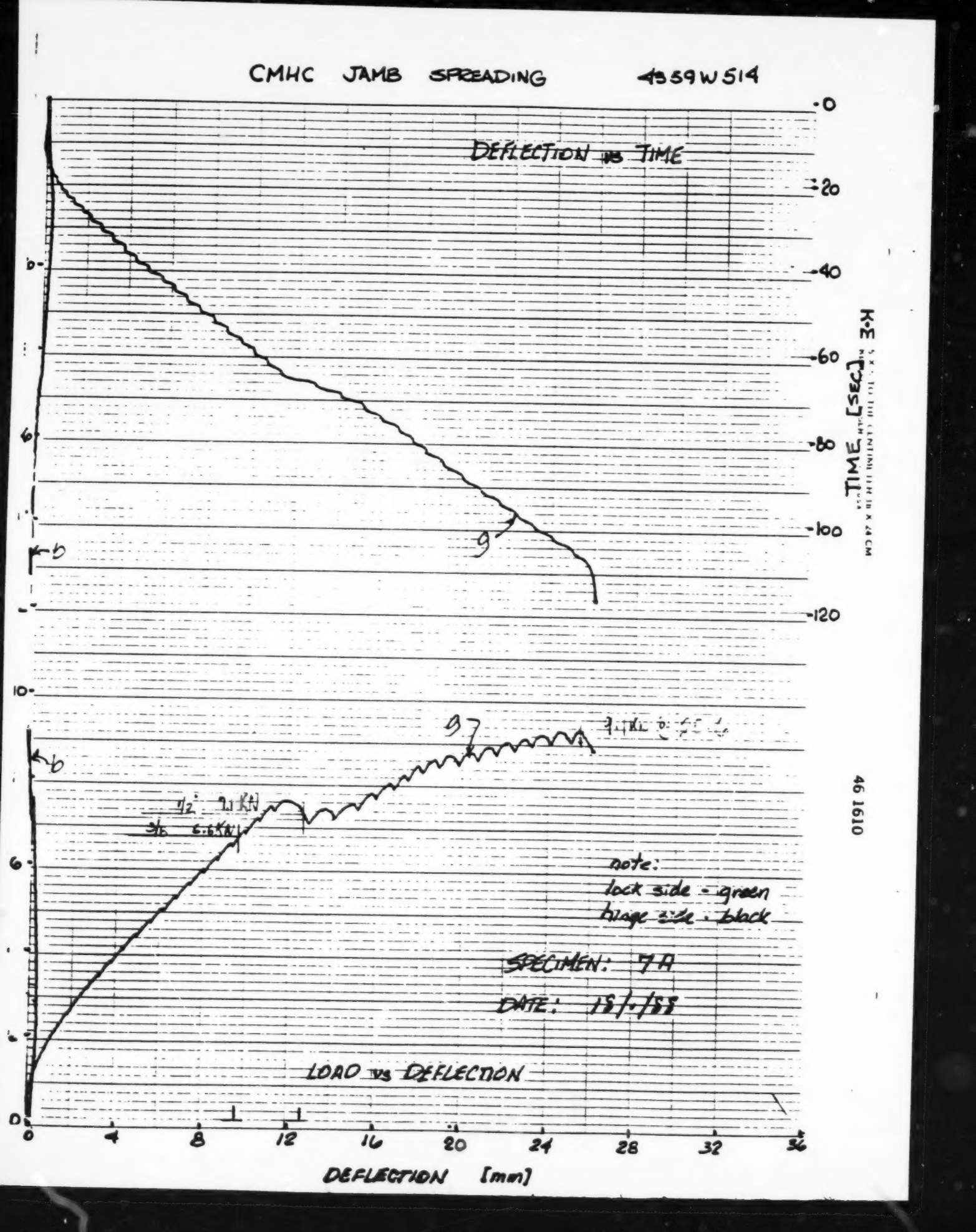
K-E 5 X 5 TO THE CENTIMETER 18 X 24 CM

46 1610

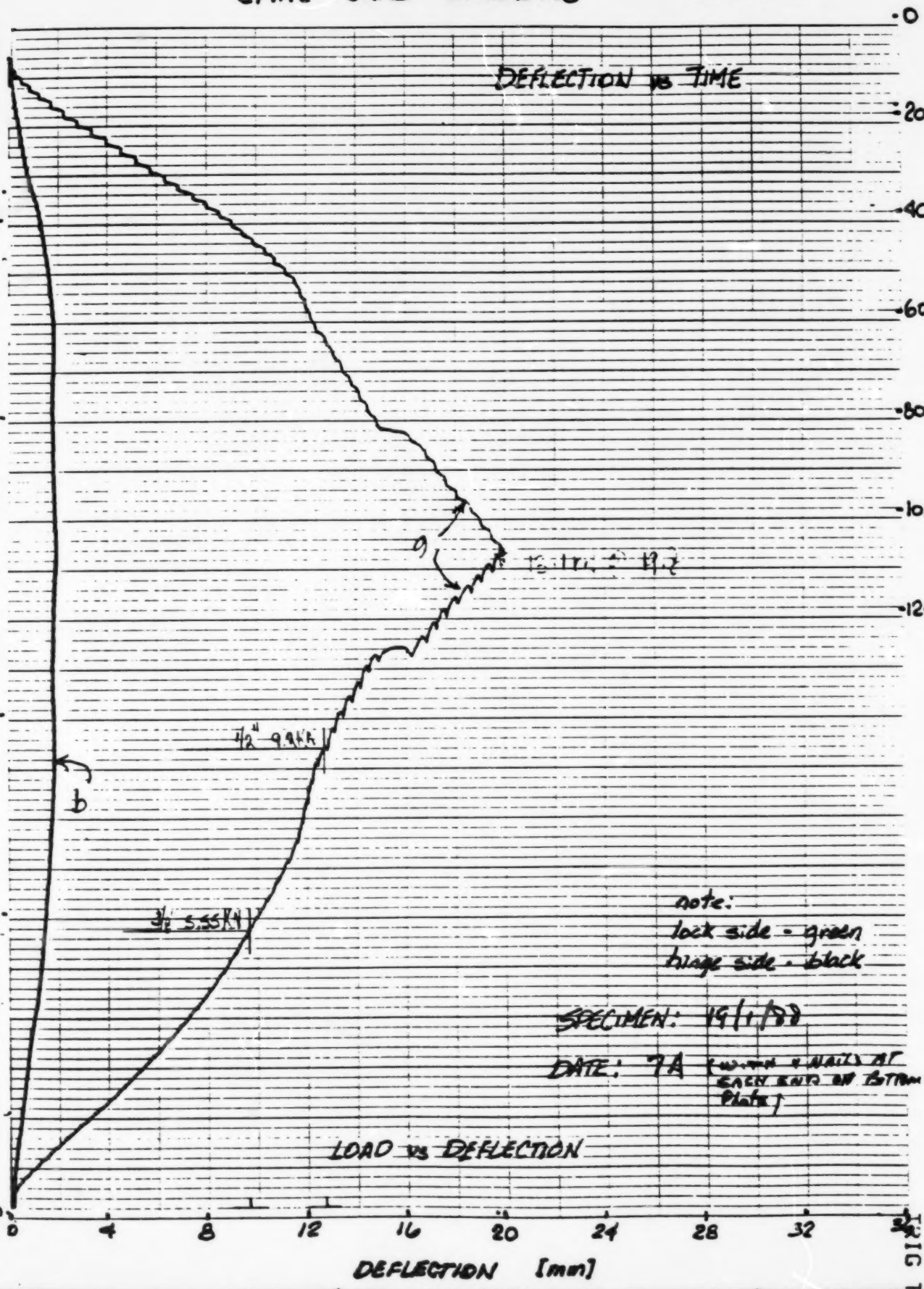

CMHC JAMB SPREADING
4559W514
DEFLECTION VS TIME
TIME [SEC]
LOAD VS DEFLECTION
DEFLECTION [mm]
note:
lock side - green
hinge side - black
SPECIMEN: 6B (RETEST SECOND TIME)
DATE: 21/1/88
46 1610


CMHC JAMB SPREADING 4359W514
DEFLECTION vs TIME
TIME [SEC]
0
20
40
60
80
100
120
note:
lock side - green
hinge side - black
SPECIMEN: 6C
DATE: 25/11/85
LOAD vs DEFLECTION
0
4
8
12
16
20
24
28
32
36
DEFLECTION [mm]
46 1610

CMHC JAMB SPREADING 4359W514



CMHC JAMB SPREADING 4359W514



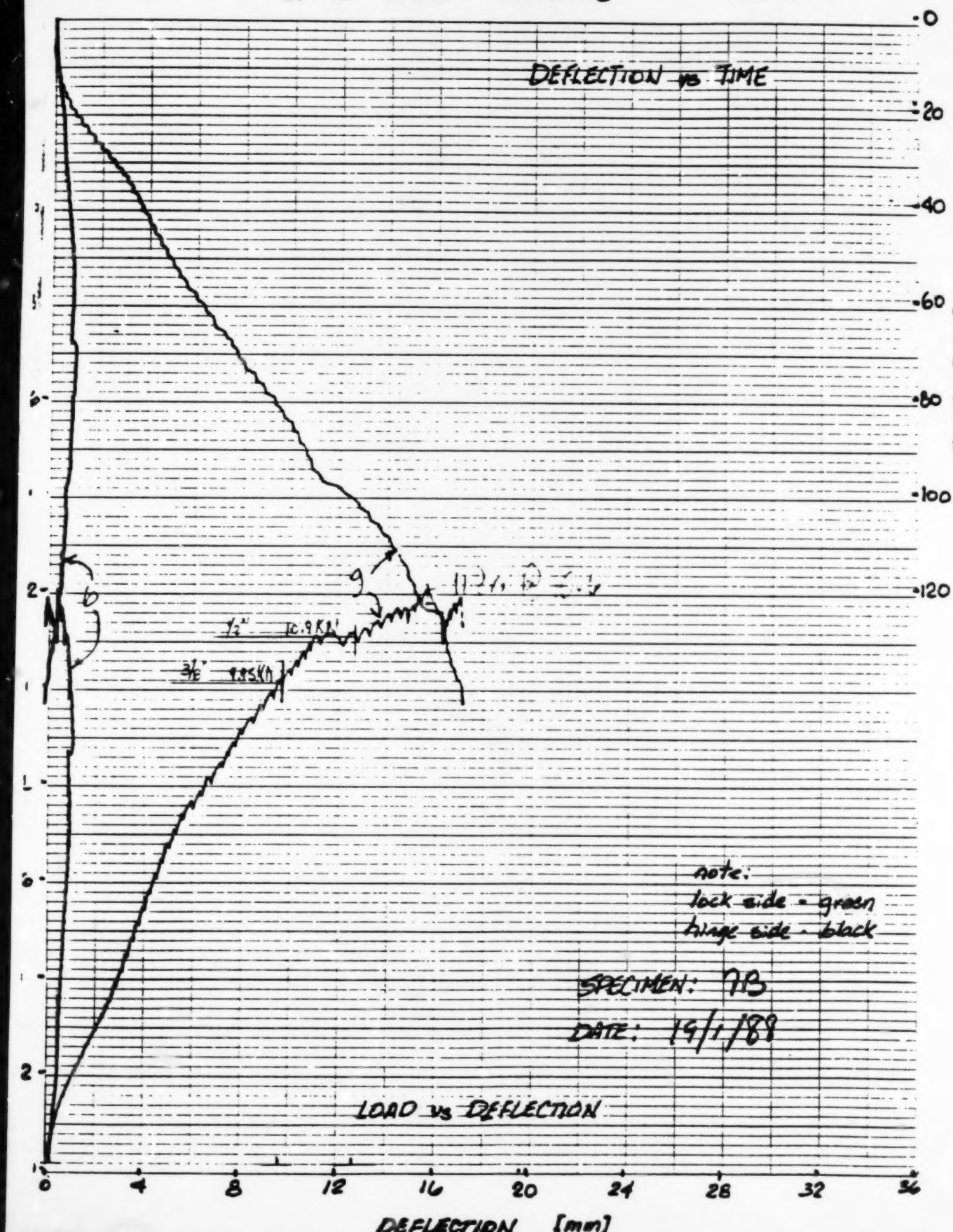
note:
lock side - green
hinge side - black

SPECIMEN: 1961/88

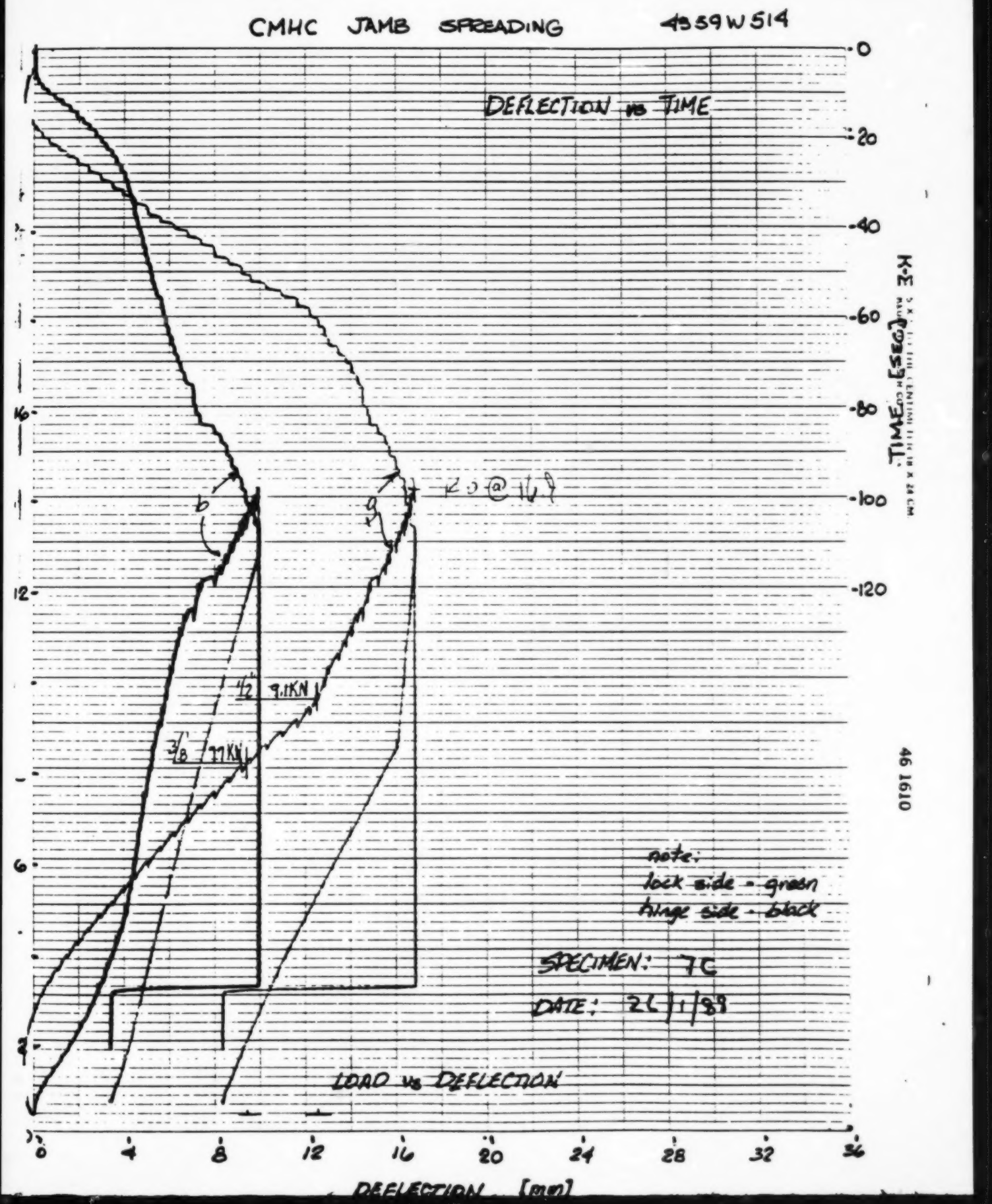
DATE: 7A [2 mm x nails at each knee on bottom plate]

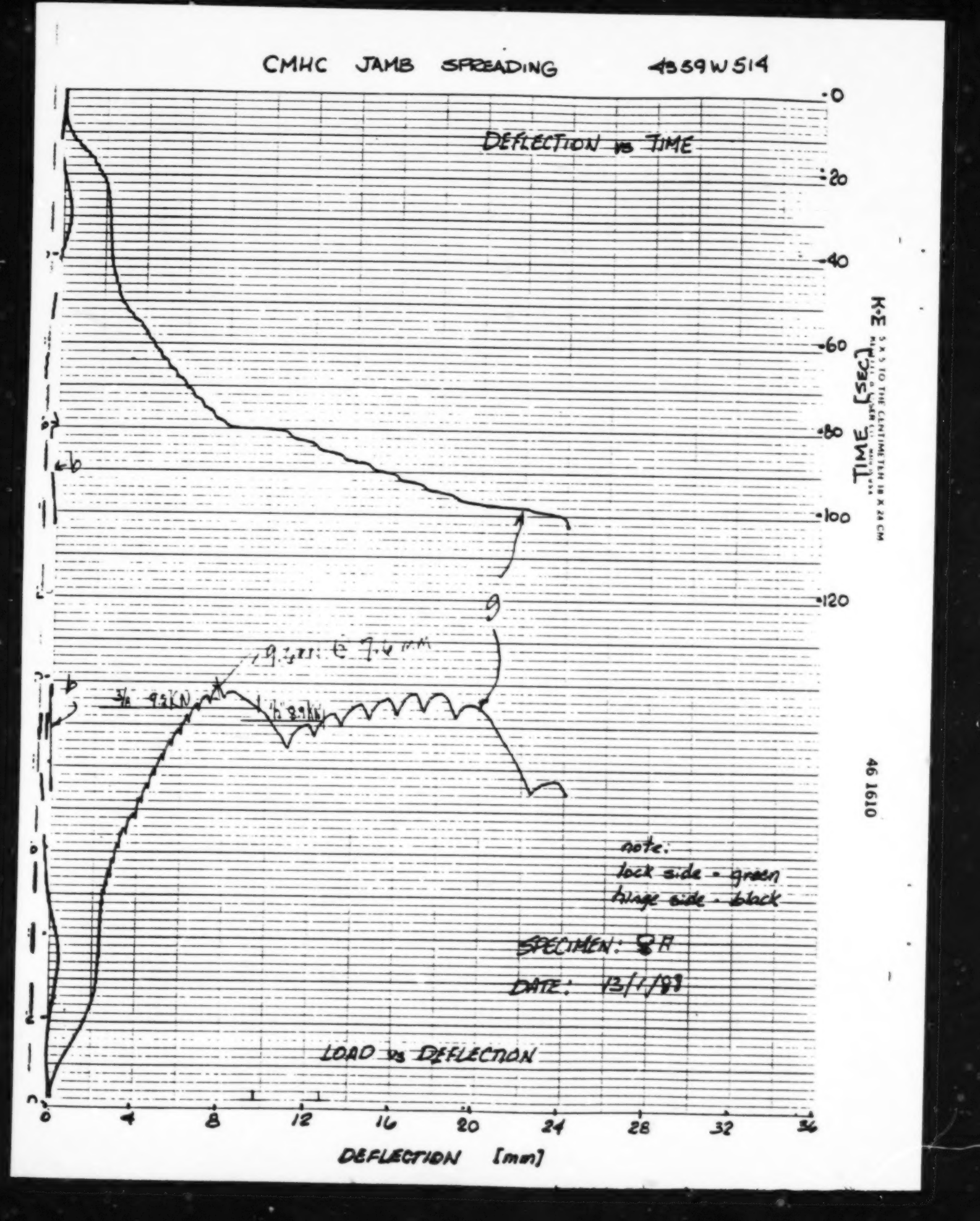
46 1610

CMHC JAMB SPREADING 4359W514



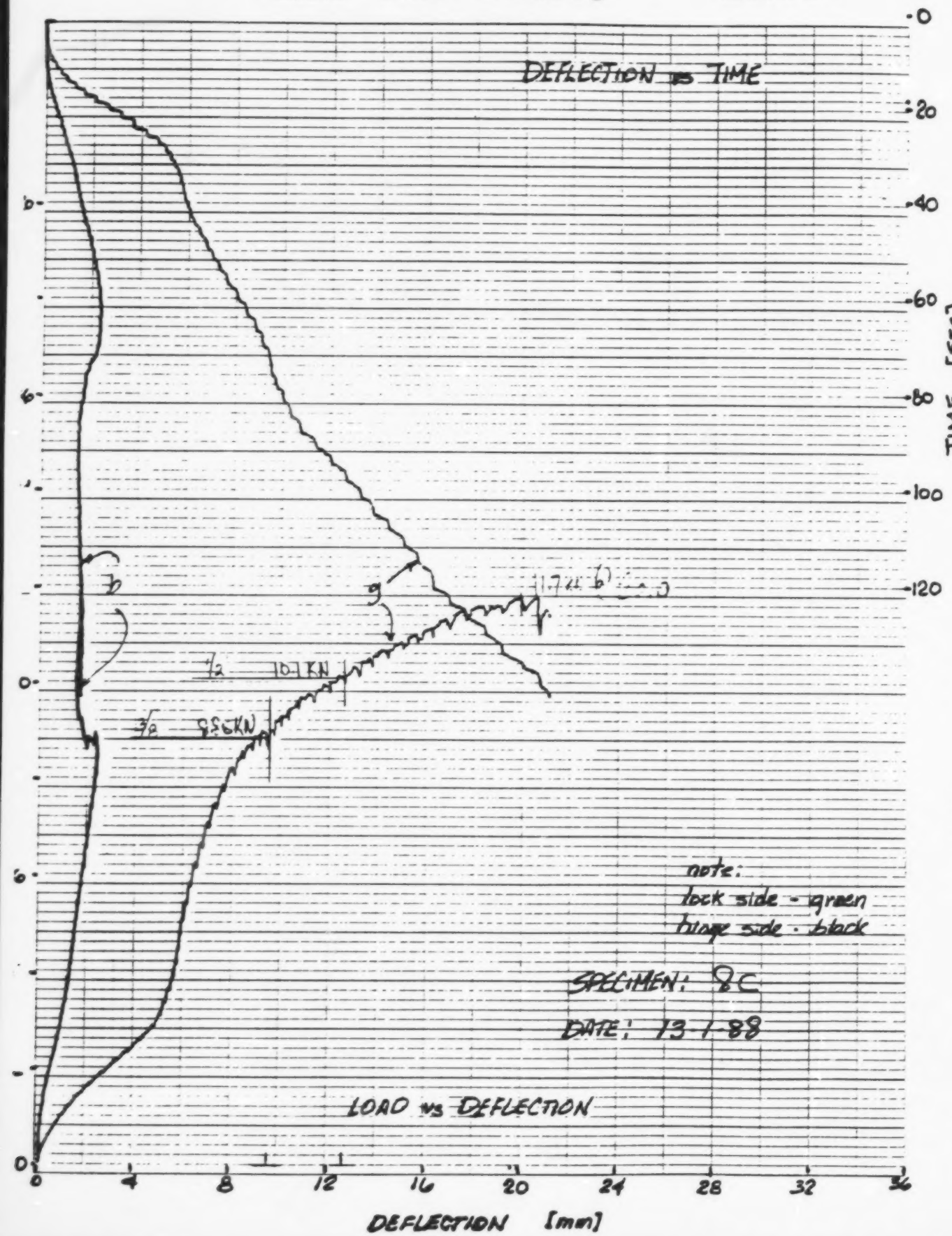
46 1610


CMHC JAMB SPREADING
4359W514
DEFLECTION VS TIME
TIME (SEC)
0
20
40
60
80
100
120
b
a
1/2" 9.1KN
3/8" 7.7KN
note:
lock side - green
hinge side - black
SPECIMEN: 7C
DATE: 26/1/89
LOAD VS DEFLECTION
0
4
8
12
16
20
24
28
32
36
DEFLECTION [mm]
46 1610

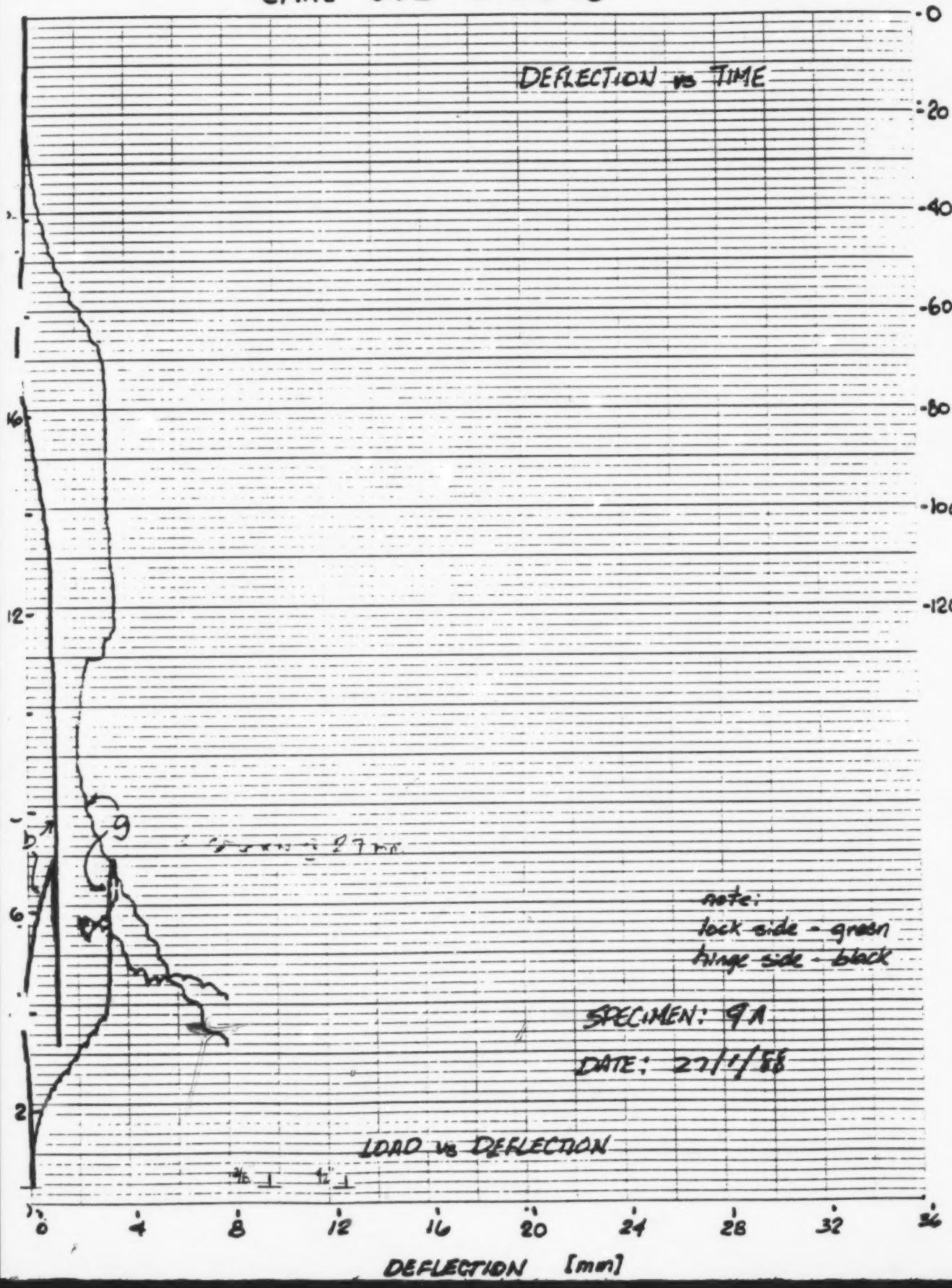

CMHC JAMB SPREADING 4359W514
DEFLECTION vs TIME
TIME [SEC]
0
20
40
60
80
100
120
9
b
3/4 9.2kN
1/4 9.2kN
note:
lock side - green
hinge side - black
SPECIMEN: 8A
DATE: 13/1/89
LOAD vs DEFLECTION
0
4
8
12
16
20
24
28
32
36
DEFLECTION [mm]
46 1610

CMHC JAMB SPREADING 4359W514

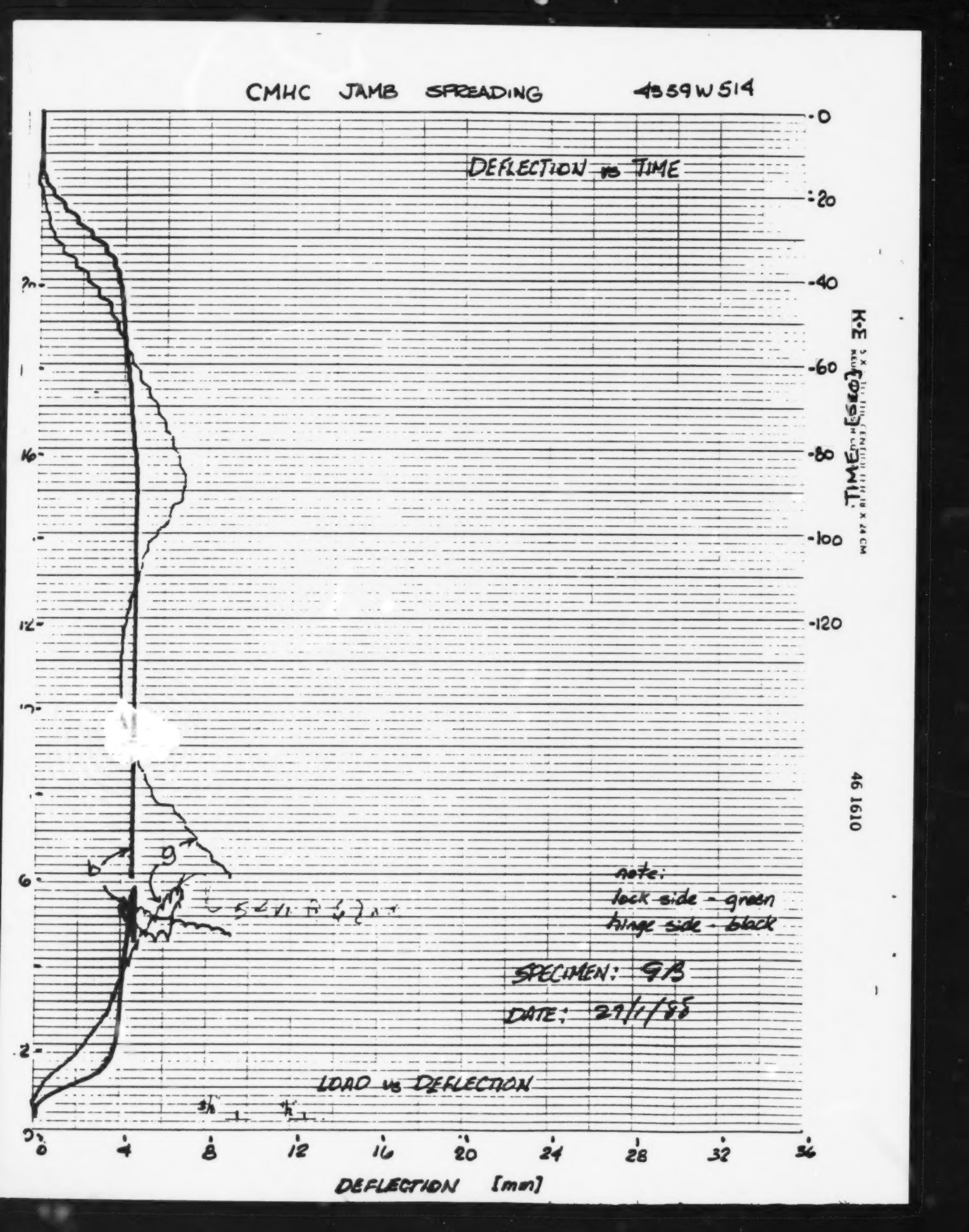
CMHC JAMB SPREADING 4359W514



CMHC JAMB SPREADING 4359W514



K+E 46 1610


CMHC JAMB SPREADING
4359W514
DEFLECTION vs TIME
TIME [sec]
0
20
40
60
80
100
120
note:
lock side - green
hinge side - black
SPECIMEN: GB
DATE: 29/11/85
LOAD vs DEFLECTION
0
4
8
12
16
20
24
28
32
36
DEFLECTION [mm]
K-E
46 1610

CMHC JAMB SPREADING 4359W514